57th Congress, 1st Session. | HOUSE OF REPRESENTATIVES. | Document No. 334.

U. S. DEPARTMENT OF AGRICULTURE.

ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR

THE YEAR ENDED JUNE 30, 1901.

February 6, 1902.—Referred to the Committee on Printing and ordered to be printed.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

THE OFFICE OF EXPERIMENT STATIONS.

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W. H. Evans, Ph. D., Botany and diseases of plants.

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J. I. Schulte, B. S., Field crops.

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D. J. Crosby, M. S., Agricultural institutions.

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H. P. Nielsen, Assistant at Kenai.

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HAWAII EXPERIMENT STATION.

Jared G. Smith, Special agent in charge, Honolulu.

T. F. Sedgwick, Agriculturist.

Frank E. Conter, Farm foreman.

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O. W. Barrett, Entomologist and botanist.

James Mackinlay, Farm foreman.

NUTRITION INVESTIGATIONS, MIDDLETOWN, CONN.

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Clarence E. Tait, B. S., Assistant in charge of maps and illustrations.

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Frank Adams, B. A., Agent and expert.

Frank Bond, B. S., Agent and expert.

To the Senate and House of Representatives:

I transmit herewith the annual report of the Office of Experiment Stations, prepared under the direction of the Secretary of Agriculture, which includes a report on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1901, in accordance with the act making appropriations for the Department of Agriculture for the said fiscal year.

The attention of Congress is called to the request of the Secretary of Agriculture that 6,000 copies of the report be printed for the use of the Department of Agriculture, and that provision be made to print such a report annually.

THEODORE ROOSEVELT.

WHITE HOUSE, *January 29, 1902.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of the Secretary,
Washington, D. C., January 25, 1902.

Sir: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, prepared in accordance with my instructions. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March, 2, 1887, for the fiscal year ended June 30, 1901, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress.

Reports are also included on the experiment stations in Alaska, Hawaii, and Porto Rico, which are provided for in the appropriation act aforesaid and are directly managed by this Department.

If this report is published by Congress it is desirable that 6,000 copies should be provided for the use of this Department, and that provision be made to print such a report annually.

I have the honor to be, sir, your obedient servant,

James Wilson,
Secretary.

The President.

LETTER OF SUBMITTAL.

OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., January 25, 1902.

SIR: I have the honor to present herewith the annual report of the Office of Experiment Stations, which includes a report on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1901. In addition to the brief accounts of all the stations, the detailed reports of the special agents in charge of the stations in Alaska, Hawaii, and Porto Rico, and summary statements regarding the special investigations in charge of this Office have been included for the first time. In the preparation of this report Mr. D. J. Crosby and Miss M. T. Spethmann, of this Office, have rendered valuable assistance.

Very respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

KEY TO ABBREVIATIONS.

Agr., Agriculture, Agriculturist, Agricultural.
Agron., Agronomy, Agronomist.
Anal., Analytical.
Archi., Architecture.
Arith., Arithmetic.
Assoc., Associate.
Asst., Assistant.
Astron., Astronomy.
Bact., Bacteriology, Bacteriologist.
Biol., Biology, Biologist, Biological.
Bot., Botany, Botanist, Botanical.
Chair., Chairman.
Chem., Chemist, Chemistry, Chemical.
Climat., Climatology, Climatologist.
Dept., Department.
Dir., Director.
Econ., Economy, Economic, Economics.
Engin., Engineer, Engineering.
Ent., Entomology, Entomologist.
Expt., Experiment, Experimental.
Flor., Floriculture, Florist.
For., Forestry.
Gard., Gardener, Gardening.
Geol., Geology, Geologist, Geological.
Gov., Governor.
Hort., Horticulture, Horticulturist.
Husb., Husbandry, Husbandman.
Indus., Industrial, Industries, Industry.
Irrig., Irrigation.
Lab., Laboratory.
Libr., Library, Librarian.
Met., Meteorology, Meteorologist.
Min., Mineralogist, Mineralogy.
Myc., Mycology, Mycologist.
Path., Pathology, Pathologist.
Phys., Physics, Physicist, Physical.
Physiol., Physiology, Physiological, Physiologist.
Pomol., Pomology, Pomologist.
Pract., Practical, Practice.
Pres., President.
Sci., Science.
Sec., Secretary.
Sta., Station.
Sten., Stenographer, Stenography.
Supt., Superintendent.
Treas., Treasurer.
Univ., University.
V. Dir., Vice-Director.
Veg., Vegetable.
Vet., Veterinary, Veterinarian.
Vit., Viticulture, Viticulturist.
Zool., Zoology, Zoologist.

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ILLUSTRATIONS.

ANNUAL REPORT OF THE OFFICE OF EXPERIMENT STATIONS, JUNE 30, 1901.

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS.

SUMMARY.

This is the seventh annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the act of Congress; the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made during the past year by the Director, assistant director, and one other expert officer of the Office of Experiment Stations.

The agricultural experiment stations in the different States and Territories, as well as the colleges with which they are connected, have been unusually prosperous during the past year. Two things have especially contributed to the greater expansion and increasing efficiency of their investigations. These are their closer affiliation with this Department and the material enlargement of the resources of the agricultural colleges, by means of which the stations have directly or indirectly been benefited.

COOPERATION BETWEEN THE STATIONS AND THE DEPARTMENT.

Much progress has been made in determining the lines in which the stations can most effectively cooperate with the Department, and the methods of arranging and conducting cooperative operations. Since both the stations and the Department have had enlarged resources, it has been possible not only to increase the number of cooperative enterprises, but also to conduct them on a larger scale. In some cases it has been found desirable to form groups of stations to investigate some problem affecting a large region. Thus, for example, a group

of stations, in cooperation with the Bureau of Plant Industry, is engaged in investigations on the breeding of varieties of cereals adapted to the Northwest. In other cases a single station is sufficiently aided by the Department to enable it to undertake the thorough treatment of problems in a special line. Thus the Pennsylvania Station, in cooperation with the Bureau of Animal Industry, is preparing to make elaborate researches in animal nutrition, and for this purpose has devised and built a respiration calorimeter for experiments with large animals, which in size and complexity surpasses any apparatus hitherto used for such experiments. In other cases, two or more branches of the Department combine to work in conjunction with a station on some complex problem. Plans are now being made, for example, for an extensive experiment on the problems of range conservation and improvement, in which the Arizona Station will unite with the Bureaus of Forestry and Plant Industry and the Office of Experiment Stations (irrigation investigations). It is evident that a very great variety of effective combinations can be made which will result in a union of forces thoroughly acquainted with local conditions with those having broad views and relations. Such a strong combination of forces for attacking the problems of agriculture exists nowhere else. It is believed, therefore, that largely increased benefits will soon accrue to our agriculture from this union of the stations with the Department. At the same time the stations were never so strong locally, and are better equipped than ever before to work by themselves on problems of immediate importance to their own constituencies.

The records of this Office show that the Department is at present cooperating with the stations in 43 States and Territories. Among the subjects on which cooperative investigations are being conducted are the following: Tests of varieties of grasses and forage plants in many localities; special experiments with grasses and forage plants for the arid region and the improvement of range lands; breeding experiments with plants, especially cereals; experiments with hybrid orange trees; the culture of sugar beets, dates, and tobacco; planting forest trees; the nutrition of farm animals and man; the gluten content of wheat; plants poisonous to stock; soil investigations; injurious insects, especially the codling moth and locust, and irrigation investigation.

EXPANSION OF STATE AID TO THE EXPERIMENT STATIONS.

With the aid of funds given by the States, buildings have been erected during the past year at a number of the agricultural colleges, which will be used in whole or in part by the experiment stations. Wyoming has just completed a new science hall at a cost of $35,000. The New York State Station has erected a residence for the director and is now expending about $8,500 in remodeling the old residence

into an administration building. North Dakota has erected two barns at a cost of $18,000 to replace the barn burned last year. Pennsylvania has finally completed and equipped its calorimeter building. Oregon has a new $3,000 station building; Storrs Agricultural College, a new dairy building; Alabama, a veterinary dissecting building and a new chemical laboratory; Colorado, an insectary; Washington, a greenhouse and insectary; Virginia, a new main barn and a piggery and abattoir; the Missouri State Fruit Experiment Station, a new station building; Kentucky, a barn for curing tobacco; New Jersey, a new barn, and Idaho a piggery.

State appropriations for substations have been made as follows: In Kansas, $3,000 a year for the establishment and maintenance of a substation at the Fort Hays Reservation; in Michigan, $2,000 for the South Haven Fruit substation and $3,000 for the Chatham substation; in Minnesota, $11,200 for improvements at the substations, which are maintained by State appropriation; in Texas, an increase of the appropriation for the Beeville substation from $5,000 to $7,500 for two years and $5,000 per annum for a new substation; in Oregon, $5,000 a year for two years for a substation in eastern Oregon; in Utah, $6,000 for two years to establish a fruit experiment station in southern Utah; in Washington, $11,200 for the substation at Puyallup, including $2,000 for improvements. Alabama has continued State aid to the Canebrake Station $2,500, and to the Tuskegee Station $1,500, and Missouri has appropriated $26,525 for buildings and maintenance at the new State Fruit Experiment Station.

Provision for the printing of station publications in whole or in part is made in the following States: California, Connecticut (both stations), Kansas, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri (both stations), New Hampshire, New Jersey, New York (both stations), North Dakota, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin.

The importance of the work of the experiment stations as distinct departments of the agricultural colleges is beginning to be recognized by special appropriations by the State legislatures for the equipment and investigations of the stations. A notable example of this was an act of the recent legislature of Illinois which appropriated $46,000 for the next two years to be expended by the station in that State as follows: Experiments with corn, $10,000; soil investigations, $10,000; investigations in horticulture, $10,000; experiments in stock feeding, $8,000; dairy experiments, $5,000; and sugar-beet experiments, $3,000. The Connecticut legislature has appropriated $2,000 per year for two years to be expended by the New Haven Station in making forestry investigations, $3,000 per year for two years for nursery inspection, and $1,800 a year for investigations at the Storrs Station on the food and nutrition of man. Florida has given $5,000

a year for two years, and Washington $1,250 a year for two years for veterinary work. The Nebraska legislature has appropriated $2,500 for investigations of the cornstalk disease and sorghum poisoning of cattle. Kansas has appropriated $5,000 for the purchase of pure-bred farm stock, with a view to extending the station work in animal husbandry. New Jersey has provided $3,000 for the inspection of foods and feeding stuffs by the State Station.

Now that the stations are well organized, appropriations of this character are likely to be most efficient means for increasing their general usefulness to the agriculture of the respective States. Funds so appropriated that they can be expended for particular investigations which may be carried on so as to broadly meet the requirements of the State as a whole, and conducted under the immediate supervision of the experienced expert officers of the station, are most likely to give results of permanent value and wide application.

PROBLEMS OF STATION ORGANIZATION.

Questions relating to the organization of the stations still continue to require the attention of the authorities charged with their management. In a number of States the organization and general attitude of the governing boards are not yet wholly satisfactory. For various reasons the boards of control as at present constituted are often not able to give close enough attention to the requirements of the stations to thoroughly understand the nature of their operations and the requisites for their most efficient work. This may be due to the frequent changes in the membership of the board, to infrequent and short meetings of the board, or to mistaken ideas on the part of the board of its proper functions. Under existing conditions no one effectual remedy for these evils is apparent. It may, however, be properly urged that the governors or other appointing officers in the several States should exercise great care in the selection of members of these boards, and should insist that they confine themselves chiefly to the selection of competent expert officers to have the direct management of the stations. It has been suggested that good might result from closer relations between this Office and the boards of control. This could be secured only by having representatives of the Office attend meetings of the boards. It is possible that an arrangement might be made by which a representative of the Office should visit each station annually at a time when the governing board is in session. This would, however, require a larger expense for traveling than is possible with the present resources of the Office.

Owing to the increased number of cooperative enterprises between the Department and the stations, it is more than ever important that the management of the stations should proceed on well defined and

permanent policies, and it may well be that the Office could accomplish much good by cultivating closer relations with the boards of control. This matter should certainly be considered in future plans for the operations of the Office.

Progress is being made in the separation of the offices of president of the college and director of the station. During the past year the office of director has been separated from that of president in Nebraska, North Carolina, and New Hampshire. In New Mexico and Tennessee, where the president retains the directorship, a vice-director has been appointed to have general charge of the station business. In South Dakota the president of the college has recently been made acting director, but it is understood that this is only a temporary arrangement pending the selection of a new director. Excluding South Dakota, there are at present 10 States and Territories in which the college president performs the functions of director of the experiment station. It is hoped that this number will be further reduced during the coming year.

Progress has also been made in securing for station officers better opportunities for prosecuting the work of research without undue hindrances arising from duties as teachers in the colleges.

In a number of instances newly appointed officers of the experiment stations have no duties as teachers in the college, and in other instances changes have been made by which the amount of teaching required of station officers has been materially reduced. Experience is each year showing more conclusively that if station officers are to accomplish the best results in agricultural investigations, their research work must be made their primary business, before which routine duties of every kind must give way as the conditions of the original work demand. Our most successful stations are now managed on the principle that they constitute university departments of the colleges, that they are thus at the summit of our system of agricultural education, and that they must be managed on the same principles as the great scientific laboratories in the universities are conducted; that is, their officers must be the best-trained experts in their respective lines, and they must be able to devote their time and energy quite fully to their investigations. They should not be expected to do any considerable amount of teaching, especially in the elements of the sciences. If they go into the class room at all, it should be rather to lay before advanced students the methods and results of the investigations which they are conducting. Undoubtedly, the financial exigencies of many of our agricultural colleges will for some time prevent the attainment of this ideal in station management, but we may reasonably expect that wherever increases in the resources of these institutions will permit, changes in this direction will be made in the management of the stations.

RELATION OF SALARIES TO OTHER STATION EXPENSES.

In planning the work of experiment stations, a common mistake is to attempt work in too many different lines. This necessitates the employment of a considerable number of officers on the station staff and thus unduly increases the salary roll. The result is that after the salaries and printing bills are paid, the remainder of the station income, when divided among the different officers charged with making the investigations, affords only a small sum for the general expenses of each investigation. This makes it necessary to conduct the individual investigations on so limited a scale that the results are either entirely unsatisfactory or do not offer a safe guide for practical application. Those stations have had the greatest success in their operations which have so limited the lines of work to their resources as to enable them to conduct investigations and then attempt in a thorough way to reduce the results to a practical basis. In a number of States the stations should either be given larger financial support or else they should contract their operations within narrower lines. Generally speaking, the relation of salaries to other expenses should receive the closer attention of governing boards and general officers of the station.

LACK OF TRAINED WORKERS.

When the experiment stations were first organized under the act of Congress of 1887, there was an insufficient number of trained investigators to fill the positions opened by the rapid expansion of the experiment station movement in this country. As their work developed, this difficulty was largely overcome, especially as tne agricultural colleges gave increased attention to supplying the need for trained men in the stations. But within the past year this difficulty has again presented itself in a new form. The results of practical importance already attained by the Department and the stations have inspired the public with such confidence in the value of agricultural research that Congress and the State legislatures have been unusually liberal to these institutions. At the same time, business enterprises requiring scientific and expert knowledge and skill for their most successful management have been unusually prosperous. The managers of these enterprises have awakened to a much clearer appreciation of the value of the services of such men as are most successful workers in our institutions in agricultural education and research. An increasing number of our best workers in these institutions have therefore received very attractive offers from the business world. So many public and private positions for well-trained and experienced workers in agricultural science and research have been opened that in some lines the demand has outrun the supply.

This has led to numerous changes in the personnel of our experiment stations, partly through the transfer of their officers to outside enterprises, and partly through the changes of officers from one station to another on account of differences in salary and other attractions.

The lack of trained investigators is especially manifest in those lines of research which have grown out of the more recent development of agricultural science. That is, it is most difficult to find efficient investigators in such lines as soil physics, agronomy, zootechny (animal production), agricultural bacteriology, and agricultural engineering.

To aid in remedying this lack, this Department is taking into its service as many young men as it can, who come in the capacity of scientific aids and student assistants. In this way it hopes not only to train men for promotion in its own service, but also to send back trained workers to the agricultural colleges and experiment stations in the different States. Under present conditions the number of such graduate students which the Department can bring into relation to itself is quite limited.

With a view to further remedying this difficulty, a movement has been inaugurated by the Ohio State University for the establishment of a Graduate Summer School of Agriculture. This movement has received the indorsement of the honorable Secretary of Agriculture and also of the Association of American Agricultural Colleges and Experiment Stations. The Ohio State University has undertaken to defray the expenses of the first session of the school, but if this proves a success, the school will hereafter be under the control of a committee appointed by the Association of Colleges and Stations. It will thus become a cooperative enterprise, and to further carry out this idea it is proposed to hold future sessions at institutions in different parts of the country. Plans are now being made to hold the first session in July, 1902. Great interest is being manifested in this project both in this Department and in the agricultural colleges. The Director of this Office will act as dean of the school and a considerable number of the leaders in agricultural education and research in this country have consented to serve on its faculty.

By bringing together in this way the most efficient and experienced workers in our agricultural institutions, the younger men already engaged in agricultural education and research, and a number of the more recent graduates of our colleges who desire to fit themselves as teachers or investigators in agricultural lines, it is believed that even though the sessions of the school cover a short period, they will do much to inspire and encourage more thorough and satisfactory preparation for work in our institutions for agricultural education and research.

DISSEMINATION OF RESULTS OF STATION WORK.

To disseminate the results of their work among our farmers the stations are issuing a great variety of publications and distributing them very widely. These publications not only include detailed accounts of their investigations, but also short summaries of the practical results and compilations of information on a great variety of agricultural topics. They are also giving much attention to the dissemination of information through the agricultural press by means of press bulletins and special articles. The number of books prepared by officers of the agricultural colleges and experiment stations is constantly growing and these range all the way from elaborate scientific treatises to very elementary and popular works.

Undoubtedly much progress has been made in recent years in acquainting our farmers with the results of experiment station work, and it is obvious even to the superficial observer that results of the work of the stations are being from year to year more generally applied on farms in different parts of the country.

But while this is true, there is still a great amount of ignorance regarding the work of the stations and especially regarding the ways in which results obtained by the stations may be applied on the farm. While the spread of education and the spirit of progress among our farmers within the past few years has been very remarkable, there is still a mass of ignorance and false conservatism which in the aggregate constitutes a vast dead weight on our agriculture. As long as one hundred out of every thousand men of voting age on our farms are unable to either read or write (as is shown to be the case by the census of 1900) it is not to be expected that the publication of the results obtained at our experiment stations through printed documents will suffice to meet the needs of our agricultural population regarding the progress of the art. Even those farmers who are accustomed to read ordinary books and newspapers are often not prepared to understand and appreciate the station publications because of lack of the necessary preliminary information. To supplement the station publications and bring the results of their work more directly home to the farmer, the stations have felt obliged to participate largely in the farmers' institutes now so generally held in many of our States. While this work has, strictly speaking, been outside their province, at least as determined by the Federal law under which most of them are organized, it has nevertheless been an efficient means of strengthening their position and securing the confidence and support of their farmer constituencies. The problem is, therefore, how to develop the farmers' institute movement in its relation to the stations so as to make the institutes more efficient and at the same time to prevent their interfering too much with the duties of station officers as investigators and writers.

FARMERS' INSTITUTES.

So important has this question of the relation of the stations to farmers' institutes become that this Office has during the past year more than ever given attention to this matter. As the result of our inquiries we are more fully convinced than ever before of the importance of the farmers' institutes as agencies for the education of our farmers. They should be liberally supported and in many parts of our country should be much more thoroughly organized than at present. According to the incomplete statistics of the institutes collated by this Office, they are now held annually in 43 States and Territories. In 19 of these they are in charge of officers in agricultural colleges or experiment stations; in 17 they are under State or county officials, and in 7 they are under the joint control of State officers and college and station officers. In the aggregate about 2,000 farmers' institutes are annually held in the United States, which are attended by over half a million farmers.

In a few of our States the farmers' institutes are quite thoroughly organized, have liberal financial support, and reach the farmers quite widely, but in many States and in the Territories the movement is yet in a comparatively weak condition and the organization and means for this work are inadequate. Moreover, even in the States where the institutes are most thoroughly organized and have had the greatest success, new problems relating to their management have arisen with the growth of the movement. For example, there is increasing difficulty in some States in securing workers thoroughly qualified for this kind of service who can attract large audiences of farmers and hold their attention through the meetings. It is a common experience that after the institutes have been held for a number of years in a given locality the farmers are not so ready to listen to local speakers, or those who have nothing to give to them except what has come within the range of their own limited personal experience, however successful they may have been as practical farmers. This is easily explained as a natural result of successful institutes. They arouse the interest of intelligent farmers in the improvement of their art and set them to studying the progress of agriculture as it is shown in the agricultural press, recent books, and the publications of the experiment stations, boards of agriculture, and the United States Department of Agriculture. In this way these men discover that the problems of the farm can not be settled off-hand by individuals, however successful they may be in a limited range of practice, but that the solution of these problems requires long-continued investigation and the joint labors of many scientific and practical workers.

RELATION TO THE STATIONS.

Farmers demand, therefore, that institute workers shall have a wide range of knowledge regarding the science and practice of agriculture

and particularly up-to-date information regarding the progress that is being made throughout the world in studying problems in agriculture both at the experiment stations and on the farm. This has led to a demand on the officers of our agricultural colleges and experiment stations for service at the farmers' institutes far beyond their ability to meet. Indeed, this demand has often been so urgent that in attempting to meet it these officers have been obliged to sacrifice their duties at the colleges and stations to the farmers' institute work. This has called forth protest from the managers of these institutions and even from the students, and has necessarily led to a restriction of the amount of service which these officers are permitted to give to the institutes. The colleges and stations have done and will continue to do much to promote the farmers' institutes, but with the growth of the movement they can not be relied upon to take relatively as large a share in this enterprise as they have hitherto unless they have special officers for this work. Moreover, even if the officers of the colleges and stations could do much more work in the institutes than is possible under present conditions, they could not fully meet the demand for trained workers in these institutes. There is need of developing a class of institute workers who shall combine successful practical experience and scientific knowledge of agriculture with the ability to address large audiences of farmers in a way not only to hold their attention, but also to impart to them definite information and instruction. Such men are now difficult to find, but without doubt the growing demand for them may be filled by offering sufficient inducements to young men to prepare themselves for a career as institute workers. This involves the creation of a corps of institute workers who shall receive sufficient salaries to induce them to make specific preparation for their work and to enable them to keep the information in their addresses up to date by studies pursued from year to year. This, of course, can not be done without increased resources for the institutes, but there is every reason to believe that the States will provide these when once the farmers are sufficiently aroused to the importance of this movement to insist upon the more perfect organization of institutes. At any rate, this problem of trained institute workers is a very important one and much thought and study should be given by our institute managers to its solution.

Another problem of increasing importance relates to the ways and means of reaching the masses of our farmers through the institutes. On the supposition that half a million of farmers now annually attend the institutes, it will be seen that out of the 10,000,000 farmers in the United States only one in twenty is directly reached by the institutes or 9,500,000 are not reached. These are without doubt in the main the most intelligent men in the business, and whatever good they receive from the institutes is disseminated to a considerable extent

among their less aggressive and more ignorant associates. But the institutes should directly reach a far greater proportion of our farmers. To do this various expedients will have to be adopted to adapt the institutes to the needs of the different classes of our agricultural population. For example, in communities where the farmers do not read the agricultural papers or experiment station bulletins, or are remote from the centers of advanced agricultural practice, demonstrations of new methods, implements, and apparatus will often have to be made. Thus in England great success has attended the traveling dairy schools, and in New York the farmers' institutes have been supplanted with demonstrations of improved culture and manuring of potatoes and other crops through simple experiments in a large number of localities. The Tuskegee Institute, in Alabama, is holding dairy institutes at the country crossroads, where the operation of simple dairy apparatus is shown to negro farmers, who come largely on muleback or on foot to attend these meetings.

RELATION TO THIS DEPARTMENT.

These examples of institute problems have been given to illustrate the fact that this movement has now reached such a stage of its development that the comparatively simple methods hitherto followed in the organization and maintenance of the institutes are not adequate for an enterprise of such magnitude as this has become. The solution of these problems will require much study, involving a comparison of methods employed in the different States and countries. In its national and international aspects there is room for much useful work by the United States Department of Agriculture, which may well aid in this as well as in other movements for the education of our farmers and the improvement of our agriculture.

Thus far the Department has done comparatively little toward helping the institutes directly. The chief service which it has rendered has been through the distribution of its publications to institute workers, who have thus been enabled to keep in touch with the progress of agriculture as reflected in these publications. Occasionally some officer of the Department has spoken at the institutes, but there has been no regular plan for the oral dissemination of the information gathered by the Department. The Office of Experiment Stations has in recent years issued a few publications giving accounts of the work of institutes in this country and similar work abroad. Following the natural course of such movements in the United States, the farmers' institutes have been developed, first through individuals and local organizations, and secondly, through the aid of the States, but the time has now come for the nation to do something to promote this great enterprise, and the present Secretary of Agriculture is convinced that the national

department over which he presides may properly engage in this work and usefully extend its operations in the interests of farmers' institutes.

Because of the intimate connection of these institutes with the general movement for agricultural education and research represented by the agricultural colleges and experiment stations, the Office of Experiment Stations is the branch of the Department which may most naturally be charged with the promotion of the interests of the farmers' institutes, and this Office is being encouraged by the Secretary to extend its efforts in this direction. From the study which we have already made of this matter, we think we are able to see several ways in which the Department may take definite action along this line. The following are some of the ways in which it appears to us the Department may help the institute:

(1) By collating and publishing information regarding the institute movement at home and abroad. This should be done in a regular way and with definite reference to the needs of institute work in this country.

(2) By furnishing the institute workers with the Department publications and information through correspondence. This is already done to a considerable extent, but may be more efficiently and thoroughly done by having in the Department a regular agency for this work. The institute workers would undoubtedly appeal to the Department with much more freedom if they felt that their work was definitely recognized there, as is the case with the agricultural colleges and experiment stations, whose officers are seeking the advice and assistance of the Department more and more each year. The institute workers should also be made to understand that they are very welcome to come to the Department, and by residence at Washington for a longer or shorter time, have opportunities for acquiring information through personal contact with the officers of the Department, the use of its library, etc.

(3) By advising and assisting institute managers with reference to perfecting organization and strengthening the work in weak places. This may be done by conferences between institute managers and the other officers of the Department who are definitely studying the problems of the institute movement, largely through observations made in the different States and Territories and foreign countries. It is in this way that the Office of Experiment Stations has been able to do much to help the experiment stations throughout the country. The visits of the officers of the Department to the stations in the different States, and the conferences held at Washington and at the meetings of the Association of American Agricultural Colleges and Experiment Stations have, it is believed, done much to systematize the work of the stations and make them more efficient. In a similar way representatives of this Office might visit the managers of the institutes and

the institutes themselves in different States and Territories, and meet representative institute managers and workers at Washington or in conferences held in different parts of the country. Already there is a successfully conducted Association of American Institute Workers which may easily be developed so as to become a very important factor in the further development of the farmers' institute movement.

(4) By sending out lecturers to address representative institutes in different States on the work of the Department. Thus far the Department has trusted very largely to its publications for the dissemination of the information which it gathers, and which has grown to be very large in extent and variety. It would hardly be practicable for the Department to be represented in a single year at any considerable number of institutes in any one State or Territory, but it is believed that more might be done to bring the work of the Department directly to the attention of the leaders in this enterprise through the attendance of Department officers at representative meetings, which might be held from time to time in the different States under such conditions as would bring together relatively large numbers of farmers. In this way the influence of the Department would be extended and its officers would have opportunities which they now lack for finding out what the farmers really desire to have the Department do for their benefit. An organization in the Department to promote this work would undoubtedly make it possible for the Department to do much more in this direction, even without any additional funds especially devoted to the purpose.

(5) In general, by acting through its Office of Experiment Stations as a sort of clearing house for the farmers' institute movement as it has done in the case of the agricultural experiment stations; that is, it would be a center for the focalization and dissemination of information and influences which would serve to develop farmers' institutes and make them a more efficient means for the education of our farmers and the improvement of our agriculture.

In order to bring this matter to a direct issue in the Department, the Secretary of Agriculture has included in his estimates to Congress an item of $5,000 to be added to the appropriation for the maintenance of the Office of Experiment Stations for the express purpose of enabling this Office to extend its work in relation to farmers' institutes. If Congress makes this appropriation, it will be used in employing an officer who will give his time and energy to promoting the interests of the institutes. This officer will be sent throughout the Union to advise with the farmers' institute managers regarding the ways in which the Department may help the institutes, will study the problems of institute management at home and abroad, and will seek to shape the Department's work for the institutes so that it may be most helpful to this enterprise. It is thought that in this way the lines of work may be

best laid so as to give promise of making the Department an acceptable and efficient agency for the promotion of the general interests of the institutes throughout the country.

EXHIBITS AT EXPOSITIONS.

The collective experiment station exhibit at the Paris Exposition of 1900, made under the general supervision of a committee of the Association of American Agricultural Colleges and Experiment Stations working in cooperation with this Office, was described in my report for 1900. At the close of the exposition this exhibit was packed for shipment under the supervision of Mr. J. I. Schulte of this Office and it arrived in this country in good condition. It was then transferred to Buffalo and with some additions was installed at the Pan-American Exposition.

Owing to the limited amount of space in the Government building available for the exhibits of this Department, only that portion of the experiment station exhibit which illustrated functions of this Office was installed in the Government building. By the courtesy of the general officers of the Pan-American Exposition, the remainder of the station exhibit was placed in the agricultural building, where it was located in immediate conjunction with the exhibits made by the New York State and Tennessee experiment stations. In this way the different functions of our experiment stations were more fully illustrated. A portion of the exhibit has since been transferred to Charleston, S. C., and installed at the South Carolina Interstate and West Indian Exposition now in progress in that city. Dr. C. F. Langworthy has represented this Office at the Buffalo and Charleston expositions.

At the recent meeting of the Association of American Agricultural Colleges and Experiment Stations it was decided to undertake the preparation of a collective exhibit of the agricultural colleges and experiment stations at the Louisiana Purchase Exposition to be held in St. Louis in 1903. The committee appointed to take charge of this exhibit is as follows: W. H. Jordan, director of the New York State Experiment Station; W. M. Hays, professor of agriculture, University of Minnesota; H. J. Waters, director of the Missouri Experiment Station; C. F. Curtiss, director of the Iowa Experiment Station, and the Director of this Office.

THE ASSOCIATION OF COLLEGES AND STATIONS.

The Association of American Agricultural Colleges and Experiment Stations held its fifteenth annual convention at Washington, D. C., November 12–14, 1901. The attendance was unusually large, and a considerable number of important matters relating to the general

interests of the colleges and stations were brought to the attention of the association and discussed. A brief account of the Washington meeting is given on page 36 of this report.

THE OFFICE OF EXPERIMENT STATIONS.

During the past year the work of the Office of Experiment Stations has continued to increase by the addition of new enterprises and the further development of those previously undertaken. Agricultural experiment stations under the direct management of this Office have been established in Hawaii and Porto Rico, and in Alaska the station work has been extended to include experiments in the Yukon Valley. Both the nutrition and irrigation investigations have been conducted on a larger scale than in previous years. The amount of material prepared for publication during the year has exceeded that for any similar period since the establishment of the Office. Unusual opportunities have been afforded for the study of the more general problems relating to the organization and development of agricultural education and research, and there is good reason for believing that along the lines already laid the Office may be able in the future to extend its usefulness in promoting these important interests. A brief account of the general business of the Office will be found on page 42.

ALASKA EXPERIMENT STATIONS.

The experiment stations at Sitka and Kenai have been continued and a station has been established at Rampart in the Yukon Valley. The chief new feature of the investigations in Alaska during the past year has been the more thorough study of the agricultural possibilities of the interior, especially of the Yukon Valley and the Copper River region. For this purpose Professor Georgeson made journeys through the Yukon Valley in the summers of 1900 and 1901, and Mr. Isaac Jones, who has been the assistant at Rampart, traversed the Copper River region in the summer of 1901. Through these journeys definite information has been obtained regarding the attempts at agricultural operations already made in the regions traversed and the possibilities for the extension of such operations. It was shown that considerable quantities of hardy vegetables, such as potatoes, cabbage, cauliflower, turnips, lettuce, and radishes are already being grown in the interior and there are large areas which may be used for this purpose and also for the production of grasses and forage plants. At the station at Rampart rye and barley were matured. At Sitka the experiments with cereals, forage crops, and vegetables were continued and a considerable number of varieties were successfully grown. Good silage was also made of native grasses and stored in a log silo.

At Kenai the experiments with cereals and vegetables were con-

tinued with considerable success. Seeds were distributed to 400 persons living in different parts of Alaska and a considerable number of reports were received of those grown during the season of 1900. It is evident that the efforts of the Government to aid in the development of agriculture in Alaska are greatly appreciated by residents of that Territory, and that they have already received substantial benefits from the work of the Alaska Experiment Station.

The assistant director of this Office, Dr. E. W. Allen, made a tour of inspection to the stations at Sitka and Kenai and reported favorably on their work. A brief report of the operations of the Alaska stations will be found on page 54, and a detailed report of the special agent in charge is given on pages 239–359.

HAWAII EXPERIMENT STATION.

The first appropriation for the establishment and maintenance of an agricultural experiment station in Hawaii was for the fiscal year covered by this report. A preliminary investigation of the agricultural conditions existing in Hawaii with reference to the establishment of an experiment station was made by Dr. W. C. Stubbs, director of the Louisiana Agricultural Experiment Stations, acting under the direction of this Office. On the basis of his report a station was established with headquarters at Honolulu, and put in charge of Mr. Jared G. Smith. The station was located on the tract of land in Honolulu known as Kewalo-uka, which was assigned to this Department by the Government of the Territory of Hawaii. About 50 acres of this tract have been cleared and several small buildings have been erected. The investigations have thus far been confined to studies of a fungus disease which seriously affects taro, and studies of the diseases of poultry. Plans are being made for experiments in horticulture, including both fruits and vegetables, and coffee culture. Cooperative investigations in irrigation will also be undertaken. A brief account of this station will be found on page 85, and a detailed report of the special agent in charge on pages 361–379.

PORTO RICO EXPERIMENT STATION.

The first appropriation ($5,000) for agricultural investigations in Porto Rico was made for the fiscal year ended June 30, 1901, and was used for making a preliminary investigation of the agricultural conditions existing in that island, with special reference to the establishment of an experiment station there. This investigation was in charge of Prof. S. A. Knapp, formerly of the Iowa Agricultural College, and on the basis of his report Congress made a second appropriation ($12,000) for the current fiscal year, which authorized the Secretary of Agriculture to establish and maintain an agricultural experiment station in Porto Rico.

In the spring of 1901 the investigations in Porto Rico were put in charge of Mr. Frank D. Gardner, who has since made his headquarters at San Juan. The work thus far has been largely confined to an agricultural survey of the island with reference to the best locations for experimental investigations. Experiments in coffee culture have, however, recently been undertaken on leased land at Rio Piedras. Studies of injurious insects and plant diseases have also been begun. Improved varieties of seeds and plants have been distributed. A brief account of this station will be found on page 176, and a detailed report of the special agent in charge on pages 381–415.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories and in Alaska, Hawaii, and Porto Rico. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 54 receive appropriations provided for by act of Congress.

The total income of the stations during 1901 was $1,231,881.55, of which $720,000 was received from the National Government, the remainder, $511,881.55, coming from the following sources: State governments, $290,305.95; individuals and communities, $1,580.59; fees for analyses of fertilizers, $82,322.40; sales of farm products, $93,363.98; miscellaneous, $44,308.63. In addition to this, the Office of Experiment Stations had an appropriation of $125,000 for the past fiscal year, including $12,000 for the Alaska experiment stations, $10,000 for the Hawaiian investigations, $5,000 for the Porto Rican investigations, $15,000 for nutrition investigations, and $50,000 for irrigation investigations. The value of additions to the equipment of the stations in 1901 is estimated as follows: Buildings, $133,420.77; libraries, $26,303.49; apparatus, $15,309.48; farm implements, $13,085.45; live stock, $18,220.29; miscellaneous, $25,025.10; total, $231,364.58.

The stations employ 688 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 52; assistants and vice-directors, 17; chemists, 146; agriculturists, 62; animal husbandmen, 14; horticulturists, 78; farm foremen, 21; dairymen, 31; botanists, 49; entomologists, 48; zoologists, 6; veterinarians, 29; meteorologists, 14; biologists, 7; physicists, 5; geologists, 5; mycologists and bacteriologists, 21; irrigation engineers, 8; in charge of substations, 12; secretaries and treasurers, 29; librarians, 11; and clerks and stenographers, 40. There are also 77 persons classified under the head of "miscellaneous," including

superintendents of gardens, grounds, and buildings, apiarists; vegetable, plant, and animal pathologists; herdsmen, poultrymen, etc.

Three hundred and twenty-five station officers do more or less teaching in the colleges with which the stations are connected.

The activity and success of the stations in bringing the results of their work before the public continue unabated. During the year they published 445 annual reports and bulletins, which are many more than are required by the Hatch Act. These were supplied to over half a million addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

FOREIGN EXPERIMENT STATIONS.

Instances of governmental activity for the advancement of agriculture in other countries are numerous, both in the Old World and the New.

The Russian Department of Agriculture and Imperial Domains has inaugurated a system of commissioners of agriculture who will correspond in a general way to our commissioners of agriculture or to our secretaries of State boards of agriculture. Each commissioner's office will have connected with it a corps of agricultural specialists, who will work among the landowners and peasants. The Russian Department of Agriculture and Imperial Domains is also displaying considerable activity in its soil and forestry investigations and in the establishment of stations for the investigation of special subjects, such as the growing of flax, cotton, olives, etc.

In Australia the Victoria Department of Agriculture is undergoing reorganization. The Victoria Royal Commission on Technical Education has brought to a close its study of Australian, European, and American departments of agriculture, agricultural schools, and experiment stations, and published its final (sixth) report. The Minister of Agriculture is now seeking a director of agriculture, who will proceed to reorganize the Department and put it on a better working basis

In England the Board of Agriculture has made larger grants than formerly to agricultural colleges and societies for conducting agricultural investigations. The Agricultural Education Committee is doing important work for agriculture and agricultural education by publishing circulars on various topics and nature-study leaflets for teachers. During the year Mr. John S. Remington has established the Aynsome Experiment Station at Lancashire, a private institution.

The Austrian Government has recently established several experiment stations, notably the station for plant culture at Brünn, the

station for investigations in plant and animal production at Otterbach, and an agricultural physiological station, with divisions of chemistry, physiology, and bacteriology, at Prague. In Hungary an experiment station for the analysis and study of wines was established last year at Fiune.

France has established at Nogent-sur-Marne a colonial garden to have administrative control over French colonial stations and botanic gardens in different parts of the world and to furnish these institutions with seeds and plants. During the year œnological stations have been established at Toulouse and Beaune and an agricultural station at Besançon.

In Germany five years of successful work at the Lauchstadt Experimental Farm, which is connected with the Agricultural Chemical Experiment Station at Halle, has given so much evidence of the value of experimental farms in connection with experiment stations that there is a movement in that country toward the extension of the so-called "American system" of field experiments, conducted on a large scale and in a more practical way than has hitherto been customary in that country. Two new stations have been established during the year, a flax-culture station at Sorau and a viticultural experiment station at Weinsberg.

In the West Indies and South America also the claims of agricultural education and research have received much attention. The Department of Agriculture in the West Indies has established three new stations at Montserrat and one at Tortola, and has conducted several meetings of planters and investigators, at which great interest in the advancement of agriculture was displayed. The Bolivian Government has established an agricultural college at Cochabamba and an agricultural school for Indians at Umala. Brazil has recently established a botanical garden and experimental demonstration field at San Vicente, and Argentina has decided to establish four experiment stations on the same general plan as those in the United States.

A review of the agricultural progress of the year would not be complete without mention of the organization of a department of agriculture, with a small staff of experts, at Bangalore by the government of Mysore, India; the establishment of a dairy station at Gembloux, Belgium; a veterinary pathological institute and animal vaccine institute at Christiania, Norway; and an irrigation experiment station at Calgary, Canada.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

OFFICERS.

President,
W. M. LIGGETT, of Minnesota.

Vice-Presidents,
W. O. THOMPSON, of Ohio.
J. H. WASHBURN, of Rhode Island.
H. J. WATERS, of Missouri.
J. H. WORST, of North Dakota.
J. C. HARDY, of Mississippi.

Secretary and Treasurer,
E. B. VOORHEES, of New Jersey.

Bibliographer,
A. C. TRUE, of Washington, D. C.

Executive Committee,
H. H. GOODELL, of Massachusetts, *Chairman.*
ALEXIS COPE, of Ohio.
G. W. ATHERTON, of Pennsylvania.
H. C. WHITE, of Georgia.
Ex officio, the PRESIDENT; the JUNIOR EX-PRESIDENT (A. W. HARRIS); the SECRETARY.

FIFTEENTH ANNUAL CONVENTION.

The fifteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at Washington, D. C., November 12–14, 1901. President A. W. Harris, of the University of Maine, presided at the general sessions and delivered the president's annual address. This address set forth clearly the more important things for which the land-grant colleges stand and summarized the results of their work. The land-grant act of 1862, was considered important not only as providing for agricultural education, but as the first sufficient recognition of study and investigation as the basis of the best success in the arts and industries. It also proclaimed the duty of the National Government to promote industrial education, and in its results demonstrated the effectiveness of governmental cooperation. The most important of the direct results of this act to agricultural colleges was the experiment station. "If the agricultural college did nothing more than to establish, maintain, and officer the experiment station, it would be justified many times over." The establishment of the agricultural colleges also caused the strengthening and broadening of industrial education along all lines and has culminated in a great system of technical education. "It is also a great result of the land-grant college to have asserted and established the doctrine

that education in all its forms, from the lowest to the highest, is a State function, in which the State has the fullest rights and for which it must bear the responsibility, sharing the privilege and responsibility with private corporations only as it thinks best." The speaker considered State aid and control in higher education as necessary to the best national development, and especially so because in this way the results of higher education become the property of all the people. The address concluded with an eloquent tribute to the memory and worth of Justin S. Morrill.

The report of the executive committee presented by its chairman, President H. H. Goodell, of the Massachusetts Agricultural College, called the attention of the association to the fact that the bill for the establishment of schools or departments of mining and metallurgy in connection with the land-grant colleges passed the Senate, but failed to be called up in the House of Representatives during the last session of Congress. The introduction of a similar bill into Congress early next session was recommended.

The report of the committee on revision of the constitution called forth a vigorous discussion. The association refused to change its name. Among the important amendments adopted were those providing that the election of officers shall be by ballot upon nominations made on the floor of the convention, and that the programme of the annual conventions of the association shall hereafter be made up and distributed sixty days before the meeting of the convention; and the subjects provided for consideration by a section of any convention of the association shall concentrate the deliberations of the section upon not more than two main lines of discussion, which lines shall as far as possible be related. Not more than one-third of the working time of any annual convention of the association shall be assigned to miscellaneous business.

The committee on graduate study at Washington reported that no progress had been made since the last convention in securing a Government bureau in Washington for the administration of graduate work. The association directed the committee to continue its efforts in this direction and, in the meantime, to secure if practicable the same opportunities for study and research in other Departments of the Government as are at present afforded graduate students in the Department of Agriculture. A resolution was also adopted by the association recording its appreciation of the action of the Government in making available the facilities for research and advanced work in the Department of Agriculture, and expressing a desire that these facilities may be still further extended and that a national university devoted exclusively to advanced study and graduate and research work be established.

The sixth report of progress was submitted by the committee on

methods of teaching agriculture. Attention was called to the publication by the Department of Agriculture of the syllabi of courses in agrotechny, rural engineering, and rural economics prepared by the committee last year. In surveying the progress of agricultural education in this country during recent years, the committee "found abundant evidence that the attitude of this association and the work of this committee as its representative have already borne good fruit in stimulating and aiding the movement for the specialization of agricultural instruction in our colleges, the strengthening of agricultural faculties, and the bettering of the material equipment for agricultural education." The committee announced its intention to prepare and publish during the coming year a report on the courses in agronomy in our agricultural colleges and the facilities for instruction in this subject.

The committee on cooperative work between the stations and the Department of Agriculture made the following recommendations as supplementary to those embodied in the report submitted at the last convention: "(1) When cooperation is desired by the station, it is deemed advisable that the proposal for such cooperation be made to the Department by the director of the experiment station. Where, on the other hand, the Department desires the cooperation of the station, it is deemed advisable that the proposal be made in the first instance to the director rather than to members of the staff. (2) While it is well understood that no financial obligations can be undertaken beyond the end of the fiscal year, yet it should be recognized that any arrangement for joint experimentation which requires some years to complete creates a moral obligation upon both parties to carry the work to a conclusion. (3) Where a line of investigation has been in progress in any State under the auspices of either institution, it is, as a rule, unwise for the other party to undertake independently the same line of investigation, at least until after full consultation upon the subject."

The committee was continued with the addition of Prof. B. T. Galloway, of the Department of Agriculture.

The report of the committee on indexing agricultural literature called attention to the fact that progress in this direction could not be made by the Department of Agriculture until its library was provided with funds for this purpose. A paper on agricultural college libraries, prepared and presented by Miss Josephine A. Clark, librarian of the Department of Agriculture, and a member of this committee, completed the report. This paper emphasized the great importance of libraries as aids to the work of investigation and instruction and pointed out the necessity of systematic arrangement and complete cataloguing of agricultural libraries. Arrangements in progress by the library of the Department of Agriculture for assisting agricultural colleges in classifying and cataloguing their libraries were explained.

The report of the bibliographer, A. C. True, noted the work of a bibliographical character being done by the Department of Agriculture, and enumerated with explanatory notes forty-four general and partial bibliographies in lines relating to agriculture issued during the past year.

The general plan of the graduate summer school of agriculture, as proposed by the Ohio State University at the last convention and approved by the executive committee, was explained by President W. O. Thompson of the university. It was stated that sufficient encouragement had been received from the leaders of agricultural education and research to warrant a decision to hold the first session of the school at the Ohio State University at Columbus, Ohio, during the summer of 1902. It was announced that Secretary Wilson had cordially approved the plan for this school, and that, acting under his advice, Dr. A. C. True, Director of the Office of Experiment Stations, had consented to act as dean of the school. The Ohio State University makes itself responsible for the general management of the first session of the school, but if it proves a success it is proposed to make it a cooperative enterprise, to be managed by a committee of control appointed by the association. Future sessions may be held at institutions in different parts of the country. This plan for the school was indorsed by the association, and a prospectus of the first session will soon be issued.

The association voted in favor of exhibits illustrating the progress of instruction and research in agriculture and the mechanic arts at the St. Louis Exposition in 1903, and committees on these exhibits were appointed.

A resolution introduced by Prof. W. A. Henry, of Wisconsin, was adopted by the association, urging upon Congress "the necessity and wisdom of providing a building for the accommodation of the Department of Agriculture which in magnitude shall be sufficient to provide for its future, as well as present needs, and which will properly represent in its architecture the enormous importance of agriculture in this country, and which will constitute a worthy addition to the Government buildings of the capital of the United States."

In the section on college work, a paper on the relation of agricultural colleges to the proposed national university, by President W. O. Thompson, of the Ohio State University, was presented, in which the writer affirmed that in his judgment "the relation of the agricultural colleges to a national university should be that of sympathetic cooperation and enthusiastic support, as against all other measures, whether proposed as substitutes or stepping-stones." This paper called forth a lively discussion, in which it appeared that there was a general sentiment in the section in favor of securing some agency under Government control for making the laboratories, museums, libraries, and other educational facilities in Washington available to advanced students.

OFFICE OF EXPERIMENT STATIONS.

An Office in the United States Department of Agriculture.

LINES OF WORK.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of the stations; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, and Porto Rico. The special investigations on the nutrition of man and on irrigation assigned to this Office have been conducted on a larger scale than formerly, largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories. The Office also did considerable work in connection with the collective experiment-station exhibit at the Paris and Buffalo expositions.

INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general business of the Office	$33,000
For the Alaska experiment stations	12,000
For the Hawaii experiment station	10,000
For the Porto Rico experiment station	5,000
For nutrition investigations	15,000
For irrigation investigations	50,000
Total	125,000

PUBLICATIONS.

During the year the Office issued 52 documents, aggregating 3,843 pages. These include 14 numbers of the Experiment Station Record, with detailed index, 18 bulletins, 5 farmers' bulletins, 1 report, 2 Congressional documents, 3 circulars, 3 articles for the Yearbook of the Department, and 6 special articles published as separates.

Experiment Station Record, Vol. XII, pp. 1189.—This contains abstracts of 348 bulletins and 55 annual reports of experiment stations in the United States, 158 publications of the Department of Agriculture, and 1,675 reports of foreign investigations. The total number of pages in these publications is 31,268. The total number of articles abstracted is 3,271, classified as follows: Chemistry, 172; botany, 158; fermentation and bacteriology, 38; zoology, 31; meteorology, 99; air, water, and soils, 135; fertilizers, 139; field crops, 353; horticulture, 320; forestry, 130; seeds and weeds, 80; diseases of plants, 248; entomology, 334; foods and animal production, 314; dairy farming and dairying, 181; veterinary science, 347; technology, 25; agricultural engineering, 56; statistics and miscellaneous, 121.

Special articles were also published in this volume of the Record as follows: Notes on horse feeding; New agricultural building at Kansas State Agricultural College; International congresses of horticulture, viticulture, and agriculture at Paris; New building for the College of Agriculture at the University of Illinois, and Russian soil investigations.

There are condensed accounts of the Proceedings of the Fourteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, and of the Seventeenth Annual Convention of the Association of Official Agricultural Chemists, 1900; and, in addition, editorial discussions of the following topics: The promotion of agriculture in Russia, agricultural experiment stations for Hawaii and Porto Rico, international congresses of agricultural experiment stations and of agricultural education at Paris, the late Sir John Bennet Lawes, the influence of the Rothamsted experiment station, experiment-station exhibits at the Paris Exposition, need of more perfect organization of the experiment stations, differentiation of the investigator from the teacher, some recent bibliographic helps, protection of crops from hail, the scope and management of the veterinary work of the experiment stations, investigation of soils in Russia, variety testing at Woburn Experimental Fruit Farm, cheese curing in the light of the enzym theory, the agricultural appropriation act, experiment station farms and the movement for their establishment in Germany, the Hawaii experiment station, and Maxime Cornu, botanist, horticulturist, and agriculturist.

MISCELLANEOUS TECHNICAL BULLETINS.

Bulletin 88, pp. 181.—Organization Lists of the Agricultural Colleges and Experiment Stations in the United States, with a List of Agricultural Experiment Stations in Foreign Countries.—This contains a list of the officers of the Association of Agricultural Colleges and Experiment Stations and of the Association of Official Agricultural Chemists; a list of institutions having courses in agriculture in the United States,

with courses of study and boards of instruction; a list of experiment stations in the United States, with governing boards and station staffs; a list of experiment stations in sixty-seven foreign countries, with their location and directors; a list of station publications received by the Office of Experiment Stations during 1900; Federal legislation affecting agricultural colleges and experiment stations, and regulations and rulings of the Federal departments affecting the stations. The bulletin contains a complete index of names.

Bulletin 93, pp. 181.—A Report on the Work and Expenditures of the Agricultural Experiment Stations for the year ended June 30, 1900.—This contains the report of the Director of this Office as transmitted to Congress.

Bulletin 94, pp. 83.—Fourth Report on the Agricultural Investigations in Alaska, 1900.—This contains the report of the special agent in charge of Alaska investigations.

Bulletin 95, pp. 100.—Report on the Agricultural Resources and Capabilities of Hawaii.—This contains a report of a preliminary investigation of agricultural conditions in Hawaii, with special reference to the establishment of an agricultural experiment station in that Territory, by Dr. William C. Stubbs, director of the Louisiana Agricultural Experiment Stations.

Bulletin 97, pp. 37.—Statistics of the Land-Grant Colleges and Agricultural Experiment Stations in the United States for the year ended June 30, 1900.—Shows the number of officers and students, endowment, equipment, and revenue of the colleges, and the number of officers, revenues, expenditures, lines of work, additions to equipment during the year, and number of publications of the stations.

House Doc. 171, Fifty-sixth Congress, second session, pp. 32.—Agricultural Resources and Capabilities of Porto Rico.—A report by Prof. S. A. Knapp on investigations of the agricultural resources and capabilities of Porto Rico, with special reference to the establishment of an agricultural experiment station in that island. The report discusses the climate, soils, and industrial conditions of the island; the agricultural and horticultural products, especial attention being given to the sugar, coffee, and tobacco industries; the character of labor and farm wages; the agricultural depression, and the possibilities of agriculture in that island, and makes recommendations regarding agricultural investigations.

Bulletin 99, pp. 192.—Proceedings of the Fourteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at New Haven and Middletown, Conn., November 13–15, 1900.—Contains in addition to the proceedings of the convention, papers, addresses, and reports on a number of subjects of interest to students and investigators in agricultural science.

Yearbook of the Department of Agriculture, 1900, pp. 115–130.—Agricultural Education in France.—Describes the system of agricultural education in that country.

Card Index of Experiment Station Literature.—Copy for 1,900 cards was prepared during the past year. The number of cards distributed has reached 21,500.

FARMERS' BULLETINS.

Farmers' Bulletin 121, pp. 22.—Beans, Peas, and Other Legumes as Food.—Beans, peas, lentils, and other legumes used fresh or dried as articles of diet are described, and their food value as compared with other vegetables and with animal foods is discussed. The principles which govern the cooking of leguminous vegetables are treated, and statistics are given of the use of such foods and their importance in the diet.

Farmers' Bulletin 128, pp. 32.—Eggs and Their Uses as Food.—Describes different kinds of eggs used for food, and summarizes the available information regarding their composition and uses and value as articles of diet.

Farmers' Bulletins 122, 124.—Experiment Station Work XVI, XVII.—The two numbers prepared during the past year of the subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries.

AGRICULTURAL EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

For accounts of the work of the stations in Alaska, Hawaii, and Porto Rico during the past year, see pages 54, 85, and 176.

NUTRITION INVESTIGATIONS.

The nutrition investigations the past year may be divided into four general classes: (1) Dietary studies; (2) digestion experiments; (3) cooking experiments; (4) metabolism experiments.

The dietary studies have been conducted in various parts of the United States, and have included the study of the diet of people of varying ages and occupations under different conditions. They furnish a considerable amount of data as to the actual food habits of persons in different parts of the country, give opportunity for comparison with the data obtained in other countries, and aid in establishing a general nutrition standard.

The digestion experiments have also been conducted in different parts of the country under widely varying conditions. By means of these experiments the digestibility of various classes of food materials, like meats, cereals, legumes, fruits, nuts, etc., is studied, and data are

obtained as to the amount of the food material consumed which is made available for use in the human body.

The cooking experiments have been made with meat, and have included the study of the effects of different methods of cooking upon the meat with reference to composition, digestibility, nutritive value, and pecuniary economy.

The metabolism experiments have been conducted with the aid of the respiration calorimeter. In these experiments the income and outgo of the body were carefully observed under different conditions of rest and work. The questions especially considered this year were (1) the relation between muscular work and the metabolism of nitrogen, and (2) the relative efficiency of fats and carbohydrates in the diet for severe muscular work. The results obtained have been unusually interesting and valuable.

All these experiments include a large amount of analytical work, as well as the determination of a considerable number of heats of combustion by means of the bomb calorimeter.

Considerable editorial work is also required to put the results of the investigations in form for publication as either technical or popular bulletins. The amount of editorial work has been somewhat larger this year than usual.

The nutrition investigations were carried on in cooperation with colleges and experiment stations in Connecticut, Massachusetts, Maine, New York, Tennessee, Illinois, Minnesota, and California.

Five technical bulletins, two farmers' bulletins, a yearbook article, and two circulars on subjects relating to the food and nutrition of man were issued during the past year's as follows:

Bulletin 84, pp. 39.—Nutrition Investigations at the California Agricultural Experiment Station, 1896–1898.—Reports four dietary studies of infants, one of the university football team during training, and one of a chemist's family; also digestion experiments with an infant on a milk diet, as well as a metabolism experiment in which the balance of income and outgo of nitrogen was determined.

Bulletin 85, pp. 51.—A Report of Investigations on the Digestibility and Nutritive Value of Bread.—This bulletin is a progress report, giving the results of experiments with men on the digestibility of bread of various kinds when eaten alone, and when forming a part of a simple mixed diet; artificial digestion experiments with the same sorts of bread; a test of skim milk *v.* water for use in mixing dough; and studies of the loss of nutrients in bread making and of methods of determining metabolic nitrogen.

Bulletin 89, pp. 77.—Experiments on the Effect of Muscular Work upon the Digestibility of Food and the Metabolism of Nitrogen.—This is a report on 16 experiments with men, undertaken for the purpose of studying the effect of muscular work upon the digestibility of a

simple mixed diet, and upon the metabolism of nitrogen, with numerous analyses of the food materials used in the experiments.

Bulletin 91, pp. 42.—Nutrition Investigations at the University of Illinois, North Dakota Agricultural College, and Lake Erie College, Ohio, 1896–1900.—This bulletin reports the results of a study of the diet of a teacher's family and of a *mechanics'* boarding club at the University of Illinois, Champaign, Ill.; of a club of women students at the North Dakota Agricultural College, Fargo, N. Dak.; and of the faculty and students at the college commons of Lake Erie College, Painesville, Ohio, including numerous analyses of the food materials used.

Bulletin 98, pp. 67.—The Effect of Severe and Prolonged Muscular Work on Food Consumption, Digestion, and Metabolism and the Mechanical Work and Efficiency of Bicyclers.—This bulletin reviews previous investigations on this subject, and reports studies of the food consumption, digestion, and metabolism of three of the contestants in a six-day bicycle race at Madison Square Garden, New York, with a critical discussion by the professor of experimental engineering of Cornell University of the mechanical work and efficiency of bicyclers based upon data secured in these studies.

Farmers' Bulletin 121, pp. 32.—Beans, Peas, and Other Legumes as Food.—For note on this bulletin see page 45.

Farmers' Bulletin 128, pp. 32.—Eggs and Their Uses as Food.—This bulletin is noted on page 45.

Yearbook of the Department of Agriculture, 1900, pp. 337–348.—The Value of Potatoes as Food.—Summarizes the available information on this subject.

IRRIGATION INVESTIGATIONS.

The irrigation investigations conducted under the direction of this Office have pursued the same general lines as heretofore, the work having been extended to meet the growing demand for information on this subject as far as the appropriation would permit.

As far as practicable, arrangements have been made to cooperate with other agencies engaged in the study of irrigation questions. These cooperative efforts include the agricultural colleges and experiment stations of California, Washington, Montana, Idaho, Nevada, Utah, Wyoming, Nebraska, Texas, Arizona, and New Mexico in the arid region, and Wisconsin, Missouri, North Dakota, and New Jersey in the humid region. The different State irrigation offices are also being aided in the study of questions for which the States do not provide sufficient means. The cooperation with the State engineers' offices includes Nebraska, Colorado, Wyoming, Utah, and Idaho, all of the arid States in which such offices have been established.

In accordance with the terms of the act creating this investigation,

it has continued to follow two distinct lines, (1) to study the laws and institutions of the different States relating to the ownership and distribution of the public water supplies, and (2) to assist the irrigators under ditches already built and the managers of the canals which supply the farms now irrigated in the improvement of methods of distributing and using water in order that the land now cultivated by irrigation may be rendered more valuable, the controversies over water rights lessened, and its economical use promoted.

Under the first division the investigation began by a study of the laws and customs governing the ownership and use of a single stream. It has been found desirable to modify this plan by taking up in turn the laws governing rights to water in a single State, as in this way the people of that State can better understand the merits and defects of the irrigation laws now in force and the measures necessary to avert the evils which have arisen under these laws or to promote development by their modification. The report on irrigation in California is the first of these special studies of State laws. The reports of the eight experts engaged in this investigation give the most exhaustive description of irrigation conditions yet published of any State. In addition, it contains a general review of the agricultural situation and possibilities of California, written by the expert in charge and based on his personal studies. A similar investigation is now being carried on in Utah.

The studies of the operation of the Colorado laws have been continued under the direction of Hon. A. J. McCune, State engineer.

The measurements of the water used in irrigation for the past season embraced a much wider area, a better equipment, and more satisfactory results than those of the previous year. Stations for this purpose have been maintained in 16 States and Territories.

The designing of instruments for measuring and recording the water used in irrigation has continued. Two new designs for water registers were furnished to irrigators and canal companies last year. The latest of these designs can be furnished irrigators at about one-half the cost of the foreign instruments formerly used.

This investigation has also secured the interest and cooperation of a large number of irrigation engineers and managers of canal companies in a series of measurements to determine the coefficient of friction in canals and laterals, especially the latter, data for the accurate determination of the flow of small ditches being very much needed.

The studies of the amount and character of the sediment carried by streams used in irrigation and its influence, beneficial or otherwise, on the land where applied has been continued.

Six technical bulletins, one Farmers' Bulletin, a Yearbook article, and a circular on irrigation have been prepared for publication during the year.

Bulletin 86, pp. 253.—The Use of Water in Irrigation.—Report of investigations made in 1899. This bulletin explains the methods in use in the arid States in the distribution and use of water in irrigation. It gives a large number of measurements made to determine the duty of water and the losses by seepage and evaporation from canals, and discusses the methods by which the water supply may be more effectively and economically utilized in the production of crops.

Bulletin 87, pp. 40.—Irrigation in New Jersey.—This bulletin gives the results of a number of experiments on different kinds of small fruits, melons, and vegetables during 1898 and 1899, made for the purpose of determining whether irrigation during short periods of drought in regions where the rainfall is usually sufficient for the maximum growth of crops will sufficiently increase the yield to pay for the works necessary to obtain the supply of water, and reports observations on the construction and cost of six small irrigation plants in New Jersey.

Bulletin 90, pp. 48.—Irrigation in Hawaii.—Discusses the climatic, soil, and other conditions as affecting irrigation in Hawaii, and gives the results of irrigation experiments, especially with sugar cane, carried on by the author for a number of years.

Bulletin 92, pp. 48.—The Reservoir System of the Cache la Poudre Valley.—Contains a description of the reservoir system of the Cache la Poudre Valley, showing the benefits to be derived from the construction of reservoirs for the storage of water for irrigation.

Bulletin 96, pp. 90.—Irrigation Laws of the Northwest Territories of Canada and Wyoming.—Includes texts of the irrigation laws of the northwest territories of Canada and of Wyoming, with the regulations, forms, and methods of procedure adopted in the administration of these laws, and discussion of the principles underlying the laws and the methods followed in their enforcement.

Senate Doc. 108, Fifty-sixth Congress, second session, pp. 73.—This is an abridged preliminary report on investigations in California.

Yearbook of the Department of Agriculture, 1900, pp. 491–512.—Practical Irrigation.—Gives simple directions for the use of the individual farmer.

THE AGRICULTURAL EXPERIMENT STATIONS IN THE SEVERAL STATES AND TERRITORIES.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute, *Auburn.*

Department of the Alabama Polytechnic Institute.

GOVERNING BOARD.

Board of Trustees—Committee on Experiment Stations: Thomas Williams, *President, Wetumpka;* Jonathan Haralson, *Selma.*

STATION STAFF.

——— ———, *President of the College and of the Station Council.*

P. H. Mell, M. E., Ph. D., *Dir.; Bot.*
B. B. Ross, M. S., *Chem.*
C. A. Cary, B. S., D. V. M., *Vet.*
J. F. Duggar, M. S., *Agr.*
E. M. Wilcox, Ph. D., *Biol.*
J. T. Anderson, Ph. D., *Assoc. Chem.*
C. L. Hare, M. S., *1st Asst. Chem.*
Thomas Bragg, B. S., *2d Asst. Chem.*
J. C. Phelps, B. S., *3d Asst. Chem.*
T. U. Culver, *Supt. Farm.*
R. W. Clark, *Asst. in Agr.*
C. F. Austin, *Asst. Hort.*
G. F. Freeman, *Sec.*

LINES OF WORK.

Work at the Alabama Station during the past year has been continued along lines of economical soil improvement, including experiments with commercial fertilizers, stable manure, and green manuring crops for the purpose of studying their respective values in raising cotton, corn, oats, and wheat; animal production and dairying with closely associated studies of animal diseases and experiments with silage and forage crops, especially sorghum, cowpeas, rye, vetch, and native grasses; and plant production, including, besides the experiments with field crops mentioned above, experiments with vegetables and orchard and small fruits, studies of plant diseases, irrigation experiments with garden vegetables, and experiments in cooperation with the Bureau of Plant Industry of this Department on hybrid oranges and tea plants. The agricultural and chemical departments have continued to cooperate in the study of the fixation of atmospheric nitrogen by legumes. The station is cooperating with the Bureau of Chemistry of this Department in studies on methods of potash analysis.

Most of the station work has been in progress several years and will be continued. The work of the agricultural department in ani-

mal industry and dairying is being extended; experiments in feeding calves have been started; feeding and grazing experiments with pigs and dairy cows are being continued, and records are being kept of the growth made on pasturage by a large number of common cattle and of the cost of maintaining a small station herd of beef cattle. A study of the fertilizer requirements of cotton on most of the typical soils of the State has been inaugurated. The veterinarian is continuing studies of infectious cerebritis, the toxic effect of cotton seed and cotton-seed meal, and the inoculation of cattle for Texas fever. The Texas-fever investigations at present are for the purpose of determining whether young stock are more immune than old, and whether native stock is born immune. The tests of native trees, the experiments with grasses and those for the improvement of cotton will be continued by the botanist. In connection with the biological survey, work on the fungi occurring in the State has been continued, as have also studies of the bacterial rot of tomatoes and two bacterial diseases of the cabbage. The veterinary department has a new brick building for dissecting purposes, and the chemical department is established in its new laboratory. The director of the station has recently published a revised and enlarged edition of Gardening for the South, by W. N. White. At the end of the year the horticulturist and biologist resigned to accept a position as specialist on fungi in the Botanical Garden in New York City, and was succeeded by Dr. E. M. Wilcox, of the Oklahoma college and station.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees for the analysis of fertilizers	8,741.95
Farm products	895.37
Total	24,637.32

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 109–113, Index to Volume 8, and the Annual Report for 1900.

Bulletin 109, pp. 15.—Strawberries.—Descriptive notes and cultural data are given on 34 varieties grown at the station, with suggestions regarding the establishment of a strawberry plantation.

Bulletin 110, pp. 39, figs. 2.—Grapes.—A general discussion of the culture of grapes under the headings of soils and planting, training

and pruning, cultivation, marketing, and insects and diseases, with brief descriptive notes on 94 varieties of grapes grown at the station.

Bulletin 111, pp. 62, fig. 1.—Corn Culture.—Details and results of variety, fertilizer, seed, and culture experiments with corn carried on at the station during several seasons are presented in tables and discussed.

Bulletin 112, pp. 36.—Orchard Notes.—Notes and tabulated data are given on the behavior of apples, figs, kaki or Japanese persimmons, hybrid oranges, peaches, pears, and plums grown at the station during the season. Mention is also made of experiments in spraying trees with kerosene oil and with crude petroleum for controlling the San José scale.

Bulletin 113, pp. 52.—Cooperative Experiments with Cotton in 1899–1900.—Data for 37 cooperative soil tests made in 1899 and 1900 in different localities of the State, of which 23 gave definite results, are presented in tables and discussed.

Index to Volume 8, pp. 15.—An index to Bulletins 108–112 and the Annual Report for 1900.

Annual Report, 1900, pp. 20.—A financial statement for the fiscal year ended June 30, 1900, and reports of the director and heads of departments reviewing the different lines of station work.

GENERAL OUTLOOK.

The work of the Alabama Station is planned with full recognition of the fact that the problem of foremost importance in that State is the restoration and maintenance of soil fertility. All other problems taken up are either subsidiary to this or are concerned with the development of diversified agriculture, which must be introduced in order to avoid a repetition of the fertility-exhausting practice of growing cotton year after year on the same land. Cotton is still the important crop of the State, and work in testing, classifying, and improving varieties and in determining its fertilizer requirements is being done, but at the same time other lines of agricultural production, such as dairying, beef and pork production, fruit growing, and vegetable gardening, are being developed. Among the results of the year may be mentioned the successful production of cabbage, cauliflower, and other vegetables under irrigation, and the discovery of means for avoiding the bitter taste imparted to cream by cows that have eaten bitterweed (*Helenium tenuifolium*). The experiments with varieties of grapes have shown that the Herbemont and the Rulander are resistant to root diseases. During the year twenty-two farmers' institutes were held under the direction of the veterinarian, who was aided by five other members of the college and station staff. The institutes were better attended than those held last year and were supported by an appropriation of $500 from the fertilizer tax.

Canebrake Agricultural Experiment Station, *Uniontown.*

GOVERNING BOARD.

Board of Control: R. R. Poole (*Commissioner of Agriculture, ex officio*), *Montgomery;* J. Huggins, *Newbern;* A. Sledge, *Whitsett;* G. D. Stollenwerck, *Uniontown;* M. Walker, *Faunsdale;* W. M. Munford, *Uniontown.*

STATION STAFF.

J. M. Richeson, *Dir. and Sec.* J. F. Connor, D. V. M., *Vet.*
M. Walker, *Treas.*

LINES OF WORK.

The work of the Canebrake Station during the past year has been along the same lines as heretofore, including investigations for the improvement of the impoverished soils of the prairie region; field experiments with cotton, corn, wheat, forage crops, fruits, and vegetables; experiments in floriculture; and studies of diseases of plants and animals.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation	$2,500.00
Farm products	370.36
Balance from previous year	1,535.87
Total	4,406.23

No publications have been issued by the station during the past year.

Tuskegee Agricultural Experiment Station, *Tuskegee.*

Department of the Tuskegee Normal and Industrial Institute.

GOVERNING BOARD.

Board of Regents: I. F. Culver, *Montgomery;* Geo. W. Campbell, *Tuskegee;* Chas. W. Hare, *Tuskegee;* Lewis Adams, *Tuskegee;* Booker T. Washington, *Tuskegee;* Warren Logan, *Tuskegee.*

STATION STAFF.

Booker T. Washington, *Principal of the Institute.*

George W. Carver, *Dir.*
Chas. W. Greene, *Manager Home Farm.*
Geo. W. Owens, *In Charge of Dairy Herd.*
William J. Claytor, *Stock Raising.*
Byrd T. Crawford, *Dairying.*
L. J. Watkins, *Floriculture and Landscape Gardening.*
W. C. Smith, *Floriculture and Landscape Gardening.*
F. H. Cordozo, *Hort.*
J. C. Banks, *Sten.*
C. J. Calloway, *In Charge of Agr. Extension Work.*

LINES OF WORK.

The work of the Tuskegee Station during the past year has included cultural and fertilizer experiments with clovers, grasses, corn, sweet

and Irish potatoes, cotton, cabbage, cassava, peas, beans, etc.; feeding experiments with concentrated feeding stuffs, bran, cotton-seed meal, acorns *v.* corn, etc.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation	$1,500

PUBLICATIONS.

The publication of this station received during the past fiscal year was Bulletin 4.

Bulletin 4, pp. 8.—Some Cercosporæ of Macon County, Alabama.—A list of 74 species of Cercosporæ, together with notes on their occurrence.

GENERAL OUTLOOK.

The Tuskegee Station has continued field and feeding experiments of a nature that will be of immediate practical benefit to the colored people of the South who come in contact with the work. Once a month the staff conducts a farmers' conference, where problems relating to the farm, stock, garden, orchard, and kindred subjects are discussed by the staff and by farmers, who come often a distance of 15 miles. The station also issues nature-study leaflets to teachers who will use them and keep up children's gardens in connection with their schools.

ALASKA.

Alaska Agricultural Experiment Stations, *Sitka, Kenai, and Rampart.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

C. C. Georgeson, M. S., *Special Agent in Charge, Sitka.*
F. E. Rader, *Asst. at Sitka.*
Hans P. Nielsen, *Asst. at Kenai.*
—— ——, *Asst. at Rampart.*

LINES OF WORK.

The work in Alaska during the past year has included experiments in growing winter rye, spring wheat, barley, oats, buckwheat, and many kinds of hardy vegetables, such as potatoes, turnips, and cabbages; fertilizer experiments, especially with seaweed and fish guano; experiments in making and storing hay; and further investigations of the agricultural possibilities of the interior of Alaska. Regular stations were maintained at Sitka and Kenai in Cook Inlet and experiments were begun on the reservation at Rampart in the Yukon Valley.

Meteorological observations were made at a number of places, as heretofore, in cooperation with the Weather Bureau of this Department. Soil and temperature records were made at Sitka, Kenai, Eagle, Fort Yukon, and Rampart. During the year a two-story barn, 25 by 50 feet, has been built on the station farm at Sitka, to furnish stable room for oxen and storage for hay and implements. A four-room cottage, 1½ stories high, was also erected here for the use of the assistant. On Castle Hill, the site of the station building, a water tank has been built to provide a water supply and fire protection for the building. During the last few weeks of the year the special agent in charge of the Alaska stations made a trip of inspection to the Kenai Station and later a similar trip to the reservation at Rampart.

INCOME.

The appropriation for the Alaska investigations for the fiscal year ended June 30, 1901, was $12,000.

PUBLICATIONS.

The fifth report on the investigations in Alaska, giving a detailed account of the operations during the year 1901, has been prepared by the special agent in charge of Alaska investigations, and is given on pages 239–359 of this bulletin.

GENERAL OUTLOOK.

At the Sitka Station, winter rye, spring wheat, barley, oats, and buckwheat matured both in 1900 and in 1901. Seaweed proved to be an excellent manure, especially for potatoes, and fish guano manufactured at Killisnoo, Alaska, was also effective as a fertilizer. Repeated tests of new ground have shown that it is very generally unproductive, requiring two or three years of thorough cultivation to make it productive.

At Kenai experiments with grains and vegetables similar to those at Sitka were partly successful. Early varieties matured, but late varieties were only partly matured when frost came. About 6 tons of hay were cut and successfully cured on natural meadows at a distance of about 6 miles from the station. The improvements at this place now include a good 2-story log house and about 8 acres of cleared land. Clearing is not very difficult in this locality, nor is the land so difficult to subdue as in other places.

In the summer of 1900 a reservation of 320 acres for experimental purposes was made at Rampart, on the Yukon River, and work was begun on this reservation in August of the same year. Winter rye

sown that month wintered perfectly and matured by August 1, 1901. Barley sown in the spring matured by the middle of August.

The results of the past year have given additional evidence that quite a number of hardy vegetables and cereals can be successfully matured in Alaska. In gardening especially there is abundant evidence at Sitka, Kenai, and other points that a gratifying amount of educational and demonstration work has been done among the people. A number of private residences in Sitka show well-directed industry in beautifying their surroundings and in maintaining creditable home gardens. Many of the natives here and at Kenai plant gardens of vegetables and flowers, some of which are well cared for and objects of pride. These gardens contain lettuce, radishes, cabbages, peas, potatoes, and other hardy vegetables; and flower beds of sweet peas, pansies, and a number of other flowers are not uncommon. The seed for planting these gardens and the directions and encouragement in maintaining them have come very largely from the special agent in charge of the Alaska stations and his assistants, whose work is becoming well and favorably known in the Territory.

Fruit growing and animal production have not yet received much attention in Alaska, and it seems desirable to undertake some work along these lines. The station has many calls for nursery stock, and some experiments in testing varieties, methods of propagation, and management should be undertaken. The demand for fresh beef and dairy products and the high freight rates on these articles when shipped in make it desirable that experiments with cattle be undertaken in connection with the experiments with cereals and forage crops. Cattle can be pastured from June to October, or even longer, and natural meadows in some localities will furnish an abundant supply of good hay. The Swedish missionary at Yakutat raises cattle which he pastures on an island where they graze until December. There is a meadow near the shore not far from his place where he cuts grass for his silo. The silage keeps well and the cattle prefer it to hay. The raising of poultry and hogs and of feeds for them are other lines of work that might well be taken up in the future.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, *Tucson.*

Department of the University of Arizona.

GOVERNING BOARD.

Board of Regents: William Herring (*Chancellor*), *Tucson;* J. A. Zabriskie (*Sec.*), *Tucson;* H. B. Tenney (*Treas.*), *Tucson;* A. V. Grossetta, *Tucson;* Governor N. O. Murphy (*ex officio*), *Phoenix;* R. L. Long (*Territorial Supt. of Public Instruction*), *Phoenix.*

STATION STAFF.

F. Yale Adams, M. A., *Acting President of the University.*

R. H. Forbes, M. S., *Dir.; Chem.*
A. J. McClatchie, M. A., *Agr. and Hort.*
G. H. True, B. S., *Animal Husb.*
John J. Thornber, M. A., *Bot.*
W. W. Skinner, M. S., *Asst. Chem.*
T. D. A. Cockerell (East Las Vegas, N. Mex.), *Consulting Ent.*
S. M. Woodward, *Consulting Met.*

J. W. Shelor, *Clerk.*

LINES OF WORK.

During the past year the work of the Arizona Station has been mainly a continuation of lines of investigation taken up in previous years, including investigations of garden, forage, and green manuring crops, grains, varieties of eucalyptus and fruits; experiments with the date palm and with sugar beets; studies of methods of irrigation; investigation of the irrigation waters of the Territory, with particular reference to their fertilizing value and salt content; investigations of soil moisture; methods of stock feeding and dairy management for southern Arizona; study of range conditions, including native grasses and also arid-region grasses, saltbushes, and forage plants from other parts of the world. The station is cooperating with this Office in irrigation investigations; with the Bureau of Soils of this Department, in soil mapping and investigations of alkali soils; with the Bureau of Chemistry, in studies of the influence of environment on the sugar content of muskmelons; and with the Bureau of Plant Industry, in experiments in date culture, plant breeding, and range improvement. For the range experiments the station has secured control of about 350 acres of land near Tucson, which has been placed in charge of the botanist of the station. One of the main objects of this work is to demonstrate the advantages of range reserves as a means of not only preserving and improving the ranges, but also of conserving moisture and preventing soil erosion and floods. In cooperation with the Bureau of Soils of this Department the station has completed a soil and alkali survey of Salt River Valley and the Buckeye country, which will for the first time give definite information concerning the nature and extent of the various types of soil and the amount, kind, and distribution of alkali salts in this region.

The date-palm orchard, after one year's operations, shows 71 per cent of the stock in good condition, 11 per cent doubtful, and 18 per cent dead. This result is considered quite satisfactory in view of the experimental methods of shipment employed, the two months' journey of the trees during the hot season, and the unfavorable conditions at the time the plants arrived. The department of animal husbandry, in addition to its scientific investigations, is doing important demonstrative and cooperative work in the testing of cows, the use of hand separators, and the dehorning of calves, in order to introduce improved methods in this important branch of agriculture. Winter irrigation

of orchards has been found beneficial and is strongly advised. At the close of the year the botanist of the station, Dr. David Griffiths, resigned to accept a position in the United States Department of Agriculture, and John J. Thornber has been appointed to succeed him.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	779.06
Miscellaneous, including balance from previous year	322.10
Total	16,101.16

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 34–37 and the Annual Report for 1900.

Bulletin 34, pp. 56, figs. 14.—Timely Hints for Farmers.—This is made up of reprints of popular articles issued by the experiment station from October 1, 1899, to June 15, 1900, based largely on the results of experiments at the station.

Bulletin 35, pp. 32, figs. 5.—Vegetable Growing in Southern Arizona.—Cultural directions based on the results of station experience are given for growing all the more common garden vegetables.

Bulletin 36, pp. 23, dgms. 2.—Experimental Work with Sugar Beets during 1900.—A detailed report on cooperative culture experiments with sugar beets carried on under the direction of the station in the Upper Gila district.

Bulletin 37, pp. 38, pls. 3, figs. 3, dgms. 3.—Winter Irrigation of Deciduous Orchards.—Earlier experiments on the effect of winter irrigation on orchard production and on the moisture content of the soil throughout the season are reviewed, further experiments along this line are reported, and principles involved in winter and summer irrigation are discussed. Meteorological observations and determinations of the moisture content of the soil are reported in tables, the latter being also shown in diagrams.

Annual Report, 1900, pp. 49, pls. 2, figs. 2.—This contains a report of the director on the work, staff, and publications of the station, including notes on additions to the station farm, the date-palm orchard, range improvement, and on needs of the station; a financial statement for the fiscal year ended June 30, 1900; and reports of the heads of departments containing the results of tests of wheat grown for milling purposes and of varieties of cereals grown for hay; results of tests of

a number of forage and green manuring plants; cultural notes and results of tests of varieties of cabbage, lettuce, watermelons, onions, cauliflower, and potatoes; a brief account of experiments in irrigating orchards in winter; results of irrigation experiments with sugar beets; notes on the different species of Eucalyptus being tested at the station; a brief account of investigations conducted at the station on the crown gall and on alfalfa root rot; notes on economic cacti; a report of feeding experiments with steers, in which is given the comparative value of corn fodder, Kafir-corn fodder, and sorghum fodder supplementary to alfalfa hay was tested, and of feeding experiments with sheep, in which the comparative value of alfalfa hay and of sorghum fodder alone, mixed, and supplemented by sugar beets, was tested; notes on feeding and testing cows and on the use of hand separators; and tabulated analyses of river and artesian waters and of sugar beets.

GENERAL OUTLOOK.

The staff of the Arizona Station have their work carefully planned and are apparently making satisfactory progress in their efforts to improve the agricultural conditions of the Territory, especially along the more important lines of stock raising, fruit production, irrigation, and range improvement. The investigations of range improvement are being vigorously prosecuted and promise to yield very valuable results for the Territory. In this work, as well as in the work with date palms, the United States Department of Agriculture is cooperating with the station. The department of agriculture and horticulture has operated upon the station farm near Phoenix, where the investigations on forage plants, grains, orchard management, and duty of water are of peculiar importance to the welfare of the region. In the same place the department of animal husbandry, now in its second year, has continued and extended its operations. The station also finds it advisable to cooperate with farmers in various parts of the Territory in testing varieties, conducting dairy investigations, etc., not only for the purpose of testing local conditions, but also for the purpose of popularizing the work of the station. A most potent factor in disseminating information and calling the attention of the people to the work of the station has been the distribution of leaflets called "Timely hints for farmers," which continue to be very favorably received. It is the purpose to make these leaflets practical and timely and to distribute them freely throughout the whole southwestern region of the United States where the conditions are similar to those in Arizona. The university with which the station is connected has received an increased appropriation for maintenance, which it is expected will be so used as to benefit the station. There is need of funds for the development of farmers' institute work in the Territory.

ARKANSAS.

Arkansas Agricultural Experiment Station, *Fayetteville.*

Department of Arkansas Industrial University.

GOVERNING BOARD.

Board of Control—Agricultural Committee: Henry Stroup (*Pres.*), *Paris;* W. H. Langford, *Pine Bluff;* V. Y. Cook, *Elmo;* J. L. Buchanan (*Pres. University*), *Fayetteville;* R. L. Bennett, *Fayetteville.*

STATION STAFF.

J. L. Buchanan, LL. D., *President of the University.*

R. L. Bennett, M. S., *Dir.*
R. R. Dinwiddie, M. D., *Path. and Bact.*
C. L. Newman, B. S., *Agr.*
Ernest Walker, B. S. Agr., *Hort. and Ent.*
J. F. Moore, B. S., *Asst. Chem.*
G. B. Irby, B. A., *Asst. Agr. at Newport.*

LINES OF WORK.

The work of the Arkansas Station during the past year has included a chemical study of fats; a study of human and bovine tuberculosis; investigations of contagious swine diseases, with field and laboratory tests of preventive vaccination against swine pest and swine plague; experiments with trucking crops to aid and encourage that line of farming; observations on insects injurious to fruits and vegetables; experiments with legumes for soil improvement, and observations on the effect produced on the soil as indicated by succeeding crops; experiments in the economic production of pork and the influence of different feeding stuffs on the quality of the same; tests of different Southern feeds in feeding sheep for mutton and for wool. Considerable work has been done in testing various plants for hay and for pasture and a report issued. A preliminary report has been issued also on the pig-feeding experiments, in which the animals were grazed on soy beans, peanuts, and chufas planted in alternate rows in the field. This work was conducted at Newport under the direction of an assistant in agriculture.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products and miscellaneous	1,007.28
Total	16,007.28

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 61–65 and the Annual Report for 1900.

Bulletin 61, pp. 17, fig. 1.—Some Hay, Forage, and Pasture Plants.—This bulletin gives the result of various tests of annual plants for hay, pastures, and forage; plants for permanent meadows and pastures; and special crops for pig raising. The value of the different crops in different portions of the State is considered in detail, and cultural directions are given. A list of the more valuable clovers and other legumes, forage plants, and grasses that have been tested at the station is appended.

Bulletin 62, pp. 18, fig. 1.—Wheat Experiments.—A report of experiments in wheat culture, embracing preparation of the soil, rotation, seeding, and variety tests.

Bulletin 63, pp. 29 (Popular edition, pp. 5).—The Relative Susceptibility of the Domestic Animals to the Contagia of Human and Bovine Tuberculosis.—This is an account of experiments along the same line as those reported in an earlier publication of the station. The susceptibility of cattle, sheep, and pigs to pure cultures of the tubercle bacillus of human and bovine origin was tested in 7 series of inoculation experiments which are reported in detail.

Bulletin 64, pp. 18, figs 5.—Notes on Celery.—Several culture, fertilizer, and irrigation experiments with celery are reported, and general suggestions are given for growing this crop.

Bulletin 65, pp. 14.—Pig Feeding Experiments.—Experiments are reported the object of which was to determine the amount of corn required to produce pork of the desired hardness where pigs had previously been grazed on such forage crops as soy beans, peanuts, and chufas. Earlier experiments in grazing pigs are reviewed and data given concerning the melting point of the fat obtained.

Annual Report, 1900, pp. 114, figs 7.—This includes a financial statement for the fiscal year ended June 30, 1900, a brief report of the director, reprints of Bulletins 61–65 of the station, notes on trial orchards being established by the station throughout the cotton-growing sections of the State, and brief mention of the occurrence of crown gall on apple trees in orchards and nurseries.

GENERAL OUTLOOK.

The Arkansas Station is continuing its well-defined policy of diversifying agriculture in regions where the continuous production of cotton has impoverished the soil. This it is accomplishing by the introduction of new legumes for forage and green manuring, by encouraging the trucking and fruit-growing industries of the State, by demonstrating the value of soy beans, peanuts, and chufas as grazing crops for hogs, and by assisting in farmers' institutes.

CALIFORNIA.

Agricultural Experiment Station of the University of California, *Berkeley.*

Department of the University of California.

GOVERNING BOARD.

The Regents of the University: Gov. H. T. Gage (*Pres.*), *Sacramento;* Louis Sloss (*Treas.*), *310 Sansome street, San Francisco;* E. W. Davis,[a] (*Sec.*), *Santa Rosa;* Jacob H. Neff, *Auburn;* C. W. Pendleton, *Los Angeles;* T. J. Kirk, *Sacramento;* A. B. Spreckels, *327 Market street, San Francisco;* Samuel C. Irving, *116 Battery street, San Francisco;* Benjamin Ide Wheeler, *Scenic avenue, Berkeley;* William T. Wallace, *799 Van Ness avenue, San Francisco;* Isaias W. Hellman, *Nevada National Bank, San Francisco;* Arthur Rodgers, *309 Montgomery street, San Francisco;* J. F. Houghton, *328 Montgomery street, San Francisco;* Chester Rowell, *Fresno;* J. A. Waymire, *Alameda;* C. W. Slack, *309 Montgomery street, San Francisco;* J. B. Reinstein, *217 Sansome street, San Francisco;* Mrs. Phoebe A. Hearst, *Mills Building, San Francisco;* W. H. L. Barnes, *Crocker Building, San Francisco;* C. N. Ellinwood, *corner Pacific avenue and Devisaders street, San Francisco;* A. W. Foster, *Mutual Life Insurance Building, San Francisco;* Garrett W. McEnerney, *309 Montgomery street, San Francisco;* George C. Pardee, *Chronicle Building, San Francisco.*

STATION STAFF.

Benjamin Ide Wheeler, Ph. D., LL. D., *President of the University.*

E. W. Hilgard, PhD., L. L. D., *Dir.; Chem.*
E. J. Wickson, M. A., *Hort.*
W. A. Setchell, Ph. D., *Bot.*
R. H. Loughridge, Ph. D., *Agr. Geol. and Phys.* (*Alkali Investigations*).
M. E. Jaffa, Ph. B., M. S., *Asst. Chem.* (*Foods, Soils, and Fertilizers*).
C. W. Woodworth, M. S., *Ent.*
A. R. Ward, B. S. A., D. V. M., *Vet. and Bact.*
G. W. Shaw, Ph. D., *Asst. Chem.* (*Soils and Sugars*).
Leroy Anderson, M. S. A., *Dairy Husb.*
George E. Colby, Ph. B., M. S., *Asst. Chem.* (*Fruits, Waters, and Insecticides*).
J. Burtt Davy, *Asst. Bot.*
Warren T. Clarke, *Asst. Ent. Pro tem.*
E. H. Twight, Diplomé E. A. M., *Vit.*
C. H. Shinn, B. A., *Inspector Sta.*
Emil Kellner, *Foreman Grounds.*

C. A. Colmore, *Clerk to Dir.*

OUTLYING STATIONS.

Southern Coast Range Station, S. D. Merk, *Patron, Paso Robles;* ——— ———, *Foreman, Paso Robles.*

San Joaquin Valley Station, John Tuohy, *Patron, Tulare;* Julius Forrer, *Foreman, Tulare.*

Sierra Foothill Station, R. C. Rust, *Patron, Jackson;* J. H. Barber, *Foreman, Jackson.*

Southern California Station, S. N. Androus, *Patron, Chino;* James W. Mills, *Foreman, Ontario.*

Chico Forestry Station, C. C. Royce, *Patron, Chico;* T. H. Bohlender, *Workman in Charge.*

Santa Monica Forestry Station, Roy Jones, *Patron, Santa Monica;* William Shutt, *Foreman, Santa Monica.*

LINES OF WORK.

The work of the California Station during the past year has followed practically the same lines as in previous years. Special attention has

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[a] On leave.

been given to the study of soils, soil moisture, and alkali, and the resistance of plants to drought and alkali; chemical studies of humus and the availability of plant food in soils; plant and seed introduction and distribution and tests of the adaptability of various introduced plants to California conditions; study of range conditions and of the distribution of grasses and forage plants; experiments with vines resistant to phylloxera, including methods of propagation and grafting; tests of species and varieties of fruit, nut, and forest trees and of their adaptability to different parts of the State; investigations relating to injurious insects and diseases and means of combating them; studies in human nutrition; and miscellaneous chemical work, including analyses of soils, waters, sugar beets, fruits, dairy products, foods and feeding stuffs, fertilizers, etc. The station is cooperating with this Office in nutrition investigations; with the Bureau of Chemistry of this Department in investigations on the gluten content of wheat, methods of analyzing soils, and the influence of environment on the sugar content of muskmelons; and with the Bureau of Plant Industry of this Department in planting and testing sand-binding plants. A recent legislative enactment requires the station to inspect Paris green offered for sale in the State.

Work has been continued at the six substations and has included irrigation, drainage, and forestry investigations and field experiments with a great variety of forage plants, cereals, and fruits. At three of these substations the water systems have been considerably improved. The more active operations at the Southern Coast Range substation at Paso Robles have been discontinued, but the station has not been entirely abandoned. The university has been given $250,000 a year for two years, in addition to its regular income. From this amount $10,000 has been set aside for the equipment and maintenance of a department of dairy husbandry.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	11,543.00
Farm products	54.79
Total	26,597.79

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 129–131, Seed List No. 5, and the Annual Report for 1898.

Bulletin 129, pp. 34, pls. 3, figs. 2.—Report on the Condition of Olive Culture in California.—This gives the results of an investigation of the causes of depression in the olive industry in California, discussed under the headings of (1) cultural conditions, including improper selection of soils and neglect of tillage, irrigation, pruning, and fighting diseases and insect pests, and (2) commercial conditions, including competition with cotton-seed oil and other oils sold as olive oil, poor harvesting and manufacturing methods, and the selection of unsuitable varieties. Pickling olives and preserving the product from bacterial growths are discussed at some length.

Bulletin 130, pp. 12, figs. 4.—Preservation of Unfermented Grape Must.—The composition of pure grape must and of the products sometimes found on the market is discussed, as well as the causes of spoiling of grape juice, and the chemical and physical means of preventing fermentation.

Bulletin 131, pp. 16, fig. 1.—The Phylloxera of the Vine.—A brief historical review of the gradual distribution of phylloxera in European countries, and its subsequent importation into California, together with notes on the life history and habits of the pest and a discussion of remedial measures.

Exchange Seed List No. 5, pp. 11.—A list of seeds of economic plants offered for exchange, and a list of seeds desired by the station.

Annual Report, 1898, pp. 367, pls. 25, figs. 34.—This contains the organization list of the station; a financial statement for the fiscal year ended June 30, 1898; a brief review of station work by the director; discussions on preparatory teaching in agricultural colleges and on farmers' institutes; reports on the examination of samples of soil from different parts of California, and studies of the endurance of drought in soils of the arid region and of moisture in California soils during the dry season of 1898; a study of the accumulation of alkali in irrigated soils used for the culture of citrus fruits, and the effect of this alkali upon the growth of these fruits; analyses of a large number of samples of soils, waters, feeding stuffs, and sugar beets; a discussion of the use of saline and alkali waters in irrigation; physical, food, and ash analyses of 7 varieties of apples grown in different parts of the State; determinations of the nicotine content of 11 varieties of tobacco grown at the station; a discussion of the nutritive value of desiccated vegetables, including analyses of evaporated potatoes and carrots; determinations of the sugar content of fresh and canned apricots; results of investigations relating to the materials used in the manufacture of cans, and to methods employed in canning food products; data concerning the physical and chemical properties of salad oil; notes on tests of various antiseptics; results of investigations undertaken to study the effect of sunlight in conserving storage water from bacterial contamination; brief notes on the olive knot and on the California

vine hopper, supplementary to earlier publications of the station on these subjects; directions for the preparation and use of several insecticides and fungicides; brief notes on a number of plant diseases; reprints of Bulletin 119 of the station on vine pruning, and 124 on lupines for green manuring, and of a station circular on extermination of weeds; notes on the growth of lupines on calcareous soils; measurements of tanbark acacias or wattle trees planted at the forestry station at Santa Monica, and determinations of the tannin content of the bark and the results of practical tanning tests; meteorological observations; a statement concerning the amount and kind of seeds and plants distributed by the station since 1886, with reports on the growth and value of roselle, fenugreek, saltbushes, and other plants included in the distribution; lists of donations to the university botanic garden; notes on plants received for identification; and detailed reports on the farm and orchard crops growing at the Foothill, Southern Coast Range, San Joaquin Valley, and Southern California culture substations, and on the trees growing at the Chico and Santa Monica forestry substations.

GENERAL OUTLOOK.

During the year the California Station has published the results of investigations with olives and other fruits, grape must, phylloxera, soils of the arid region, alkali in irrigated soils, tobacco, legumes, and forest trees. The diversified productions of California necessitate a wide range of investigations, and hence the attempt has been made to study problems more or less local in nature at the substations. Thus, for twelve years the substation near Paso Robles has been made the center of observations relating to the deciduous fruit interests over an extensive region; the substation near Jackson has investigated the fertilizer needs of that region, using with success vetches and European lupines, and has successfully grown olives for oil, besides starting a plantation of Smyrna and Capri figs; and the substation near Pomona has been the center of a wide range of studies on citrus fruits, particularly the orange. The general success of the station's operations has led to a popular demand for more work than the station has funds to support. To carry on thoroughly satisfactory investigations for so large an agricultural region as is found in the State of California, the station needs larger financial resources, and with the increased resources of the college of agriculture of the university, it is hoped that it may be possible to extend the operations of the station. The number of outlying substations should either be reduced or more ample provision should be made for their maintenance under conditions which will bring their work into more direct relation with the operations of the central station.

COLORADO.

Agricultural Experiment Station, *Fort Collins.*

Department of The State Agricultural College of Colorado.

GOVERNING BOARD.

P. F. Sharp (*Pres.*), *Denver;* B. U. Dye, *Rockyford;* W. R. Thomas, *Pruden*; Harlan Thomas, *Denver;* James L. Chatfield, *Gypsum;* B. F. Rockafellow, *Canon City;* Mrs. Eliza F. Routt, *Denver;* Jesse Harris, *Fort Collins;* Gov. J. B. Orman, *Denver;* President B. O. Aylesworth, *Fort Collins.*

STATION STAFF.

Barton O. Aylesworth, M. A., LL. D., *President of the College.*

L. G. Carpenter, M. S., *Dir.; Met. and Irrig. Engin.*
C. P. Gillette, M. S., *Ent.*
W. P. Headden, M. A., Ph. D., *Chem.*
B. C. Buffum, M. S., *Agr.*
Wendell Paddock, M. S., *Bot. and Hort.*
A. H. Danielson, B. S., *Asst. Agr.*
F. M. Rolfs, B. S., *Asst. Hort.*
A. M. Hawley, *Sec.*
A. D. Milligan, *Clerk and Sten.*
Fred Alford, B. S., *Asst. Chem.*
Earl Douglass, *Asst. Chem.*
R. E. Trimble, B. S., *Asst. Met. and Irrig. Engin.*
E. D. Ball, M. S., *Asst. Ent.*
Ray Calloway, *Farm Foreman.*
H. H. Griffin, B. S., *Field Agent, Arkansas Valley Substa., Rockyford.*

J. E. Payne, M. S., *Field Agent.*

LINES OF WORK.

The work of the Colorado Station for the past year has been similar to that of former years, including studies of irrigation problems; variety tests of wheat and oats for different altitudes; feeding experiments with Belgian hares, lambs, and swine; horticultural, entomological, and chemical investigations; and meteorological observations. The work of the irrigation engineer has included investigations on the use of water for irrigation as applied on different farms under varying conditions, and measurements of seepage, the latter for the special purpose of determining the important relation between the area irrigated, or the amount of water applied, and the amount returned. These measurements are made on the Platte, the Arkansas, the Rio Grande, and their tributaries, and have been extended recently some 40 miles above the section formerly measured on the Rio Grande. Measurements are also being made of losses from ditches, principally in the Cache la Poudre and Arkansas valleys, and the best means for economizing water are being studied. The principal horticultural work is the study of a disease of peas and the continuation of variety tests of native plums and small fruits. The entomologist is investigating the ravages of the codling moth, peach twig and apple twig borers, various leaf rollers, cutworms on alfalfa, grasshoppers, and insects working on sugar beets and cantaloupes, and is continuing tests of comb foundations and studies of foul brood. The chemical work includes analysis of water used in irrigation; studies of means for extracting beeswax from old combs; sugar-beet investigations; soil

analysis, especially as related to the humus and alkali problems and nitrification; studies of methods of analysis of feeding stuffs, especially the composition of the proximate groups; and digestion experiments.

Among lines of work outlined for investigation in the immediate future are investigations bearing on the accurate determination of the duty of water in irrigation, tests of forage plants, improvement of pastures and waste lands, and experiments in stock feeding. A $10,000 barn is now being built, which contains feeding stalls costing $1,200. During the year an insectary has been constructed, and the college has made plans for a $40,000 engineering building, which will contain offices for the director and irrigation engineer of the station. At the beginning of the year B. C. Buffum, of Wyoming University, succeeded W. W. Cooke as agriculturist of the station, and Wendell Paddock succeeded J. H. Cowen, deceased, as botanist and horticulturist. A veterinary department has been established and Dr. G. H. Glover has been placed in charge. The mailing list has been changed from book to card-index form, and press bulletins have been published. A feature of the bulletin work has been the issuing of "river press" bulletins, noting weekly measurements of water in the Cache la Poudre River, which have been distributed to those in the northern part of the State interested in the condition of water in that river.

The substation at Cheyenne Wells has been abandoned, and at Rockyford the work has been confined to tests of the adaptability of varieties of grains, fruits, grasses, and forage crops to the region; culture of sugar beets; culture and improvement of melons; propagation, culture, and fertilization of tomatoes; feeding experiments with sheep (cooperative, without expense to the station) to determine the feeding value of beet-sugar factory pulp. The station has arranged several lines of investigation in cooperation with this Department, including a study of the codling moth, with the Division of Entomology; studies of the gluten content of wheat and of the influence of environment on the sugar content of muskmelons, with the Bureau of Chemistry; tree planting, with the Bureau of Forestry; and experiments with forage crops for alkali and arid soils, with the Bureau of Plant Industry.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,280.10
Miscellaneous, including balance from previous year	624.34
Total	16,904.44

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 54, 56–63, and the Annual Report for 1900.

Bulletin 54, pp. 28, pls. 6.—Apiary Experiments.—Investigations in regard to what extent and in what form wax can best be furnished bees for their use in building comb are reported. The experiments were conducted to answer the following questions: Do bees use wax from artificial foundations to extend the cell walls and the comb midrib? Is the wax of the midrib of the foundation used in comb building? Does the use of artificial foundations result in thicker cell walls in the comb? To what extent does the foundation lessen the secretion of wax by bees? Methods of using foundation in sections were compared and substitutes for pollen tried.

Bulletin 56, pp. 63.—The Birds of Colorado.—A second appendix to Bulletin 37 of the station on the same subject, containing corrections and additional notes on the birds of Colorado.

Bulletin 57, pp. 39.—Farm Notes.—This bulletin is a résumé of the results of different experiments with alfalfa, corn, potatoes, and sugar beets carried on at the station during the years 1894–1899. The work has all been reported in previous publications of the station except cooperative culture experiments with sugar beets.

Bulletin 58, pp. 46.—A Soil Study of Sugar Beets.—Experiments here reported embrace a study of irrigation, manuring, and alkali content of the soil in connection with sugar-beet culture, and an investigation on the influence of drying and soaking the beets and the size of the beets on the composition.

Bulletin 59, pp. 16, pls. 2, map 1.—Investigation of the Great Plains—Field Notes from Trips in Eastern Colorado.—Information obtained from interviewing settlers in Kit Carson and Arapahoe counties as to methods employed and results obtained in tree planting, fruit growing, and stock raising is given, together with notes on methods of irrigation, the results obtained with different field crops, character of the soil, weeds, and insects.

Bulletin 60, pp. 12.—Bush Fruits, including Gooseberries, Raspberries, Blackberries, Dewberries.—Brief cultural notes with the results of tests of 6 varieties of gooseberries, 12 of currants, 23 of raspberries, and 12 of blackberries and dewberries.

Bulletin 61, pp. 10.—Bromus inermis.—Directions for the culture of this grass, with the results of tests on the college grounds and at the Arkansas Valley and the Plains substations since 1892.

Bulletin 62, pp. 18, pl. 1.—Cantaloupes.—An account is given of the methods followed in growing cantaloupes at Rockyford, together with the results of some experimental work along the lines of irrigation, fertilizing, and transplanting, and data on the proportion of male

and female flowers produced on muskmelon vines on different dates during the season. A blight of cantaloupes due to *Macrosporium cucumerium* is described, and experiments carried on during two years for the control of this disease are reported. Other diseases and insect enemies of cantaloupes are noted.

Bulletin 63, pp. 32.—Sugar Beets.—A review of the work with sugar beets carried on at the station up to the present time and reported in earlier bulletins of the station.

Annual Report, 1900, pp. 149.—This includes a financial statement for the fiscal year ended June 30, 1900; a report of the director, giving the regulations of the State board of agriculture governing the operations of the station, detailed plans for station work for 1900, and a general review of the work of the station and substations; departmental reports, giving detailed accounts of the different lines of station work and containing brief biologic and economic notes on a large number of insects and measurements to determine the gains or losses from seepage; a report of the superintendent of the Arkansas Valley substation, giving notes on experiments with cantaloupes, sugar beets, tomatoes, grasses and leguminous plants, potatoes, wheat, and apples; a report of the superintendent of the Plains substation, including notes on the fruits, vegetables, and field crops under cultivation, notes on the forest trees planted as wind-breaks, observations on soil moisture, and notes on the agricultural conditions of eastern Colorado; a tabulated daily and monthly summary of meteorological observations during 1900; a tabulated record of weekly observations on soil temperatures at different depths in irrigated and unirrigated soils; and observations on evaporation from water surfaces.

GENERAL OUTLOOK.

The Colorado Station has been undergoing a gradual reorganization since the appointment of the present director two years ago. The result is a greater unification and concentration of experimental work along lines of primary importance to the agriculture of the State. Except at Fort Collins, the work done is assuming more and more the nature of a reconnoissance for the purpose of discovering the agricultural possibilities of the different sections of the State. From reports already made, it appears that next in importance to the investigation of problems in irrigation come those related to stock raising, such as production and use of feeding stuffs, securing and maintenance of permanent pasture, production of useful plants on waste lands, and trials of native hay and pasture grasses on new ranges. Some difficult problems attend the growing of potatoes, an important crop of the State, and these, together with problems in fruit growing, the production of pears, cantaloupes, tomatoes, and other field and garden crops, and the

suppression of destructive insect pests, demand and receive attention. In connection with all of these problems those of irrigation are more or less important and must be considered. The director, relieved now in a measure from the unusual burden of reorganizing the station, proposes to give more time to investigations bearing on the accurate determination of the duty of water in irrigation, and to undertake scientific investigations of the water requirements of specific plants under different climatic and soil conditions. This is an important line of work, and one which the Colorado Station is in an excellent position to undertake. With the growth of agricultural interests in Colorado and the development of the agricultural college there is increasing need of additional funds for the work of the station, and it is hoped the State will shortly supplement the national funds for this purpose.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

GOVERNING BOARD.

State Board of Control: Governor George P. McLean (*Pres.*), *Hartford;* W. H. Brewer (*Sec.*), *New Haven;* E. H. Jenkins (*Treas.*), *New Haven;* W. O. Atwater, *Middletown;* Edwin Hoyt, *New Canaan;* J. H. Webb, *Box 1425*, *New Haven;* T. S. Gold, *West Cornwall;* B. W. Collins, *Meriden.*

STATION STAFF.

E. H. Jenkins, Ph. D., *Dir.*
A. L. Winton, Ph. B., *Chem.*
T. B. Osborne, Ph. D., *Chem.*
A. W. Ogden, Ph. B., *Chem.*
M. Silverman, Ph. B., *Chem.*
I. F. Harris, Ph. B., *Chem.*
W. E. Britton, B. S., *Hort. and State Ent.*
Walter Mulford, B. F., *In Charge of Forestry Work and State For.*
Miss V. E. Cole, *Libr. and Clerk.*
Miss L. M. Brautlecht, *Asst. Clerk.*
William Vietch, *In Charge of Buildings and Grounds.*
Hugo Lange, *Lab. Asst.*
William Pokrob, *Lab. Asst.*
J. B. Olcott, *Grass Gardener* (*South Manchester*).
V. L. Churchill, *Sampling Agent.*

LINE OF WORK.

The Connecticut State Station during the past year has continued lines of work formerly established, and inaugurated some new investigations. The study of vegetable proteids has been continued, as have also studies of the availability of organic nitrogen in various forms by means of pot experiments with Hungarian grass and redtop grass; forcing-house experiments with tomatoes; experiments in grafting chestnuts; forestry experiments for the utilization of waste lands; spraying experiments; study of diseases of vegetables; tobacco investigations; seed testing; and the analysis and control of fertilizers, foods, and feeding stuffs. In connection with the fertilizer and food inspection the station chemists have analyzed a large number of sam-

ples of Hungarian and redtop grasses, and have studied analytical methods for the detection of adulterations in food products. Observations were made on a widespread disease of peach trees and raspberry vines related to the crown gall, but far more destructive, and material was collected for future study.

During the year Prof. S. W. Johnson, advising and consulting chemist, entirely severed his connection with the station. W. E. Britton, horticulturist, has been made State entomologist under the provisions of a State law concerning insect pests, approved June 10, 1901, which appropriates $3,000 a year for nursery inspection, the salary of the entomologist to be paid by the station. The office of State forester has also been created and filled by the appointment of Walter Mulford, whose salary will be paid by the station, and who will have charge of the forestry work for the station in addition to the State forestry work, for which an appropriation of $2,000 per year was made. Station work in forestry was begun with planting white pine, white oak, and chestnut on a 100-acre lot at Poquonock belonging to the station.

INCOME.

The income of the station for the past fiscal year was as follows:

United States appropriation	$7,500.00
State appropriation	12,500.00
Individuals and communities	1,580.59
Fees	7,730.40
Farm products	911.85
Miscellaneous	139.91
Total	30,362.75

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 131–133 and the Annual Reports for 1899, Part III, and 1900, Parts I, II, and III.

Bulletin 131, pp. 30, pl. 9.—The Protection of Shade Trees in Towns and Cities.—An account of the present condition of shade trees in the city of New Haven, Conn., statements concerning the causes of their destruction, suggestions for protecting shade trees against various injuries, outline of the duties of a city forester, and brief descriptions of trees most suitable for street planting.

Bulletin 132, pp. 7.—Condimental and Medicinal Cattle and Poultry Foods.—Analyses of 15 samples of condimental and medicinal cattle and poultry foods, with a brief discussion of this subject.

Bulletin 133, pp. 29.—Commercial Feeding Stuffs in the Connecticut Market.—An account of the inspection of feeding stuffs during 1900, including tables showing the chemical composition, digestible nutrients, and cost per ton of 186 samples of commercial feeding stuffs collected in 25 towns and villages in the State.

Annual Report, 1899, Part III, pp. 211, pl. 3, fig. 1.—This contains a detailed account of experiments on (1) the availability to grass of nitrogen in form of nitrate of soda, cotton-seed meal, and fine, hard bone; (2) the availability to Hungarian grass of nitrogen in form of nitrate of soda, cotton-seed meal, and raw, boiled, and steamed bone; and (3) the availability of the nitrogen of hard, raw bone as affected by applications of slaked lime; observations on the effect of nitrogen in the form of nitrate of soda, cotton-seed meal, and ground bone upon the growth of California privet; detailed results for 1899 of extensive experiments in the use of commercial fertilizers and different soils in growing tomatoes, lettuce, and carnations under glass; a brief account of investigations of a stem-rot disease of carnations due to a species of Fusarium; notes on the effect of winter upon chestnut grafts and scions; brief notes on a number of injurious insects; a reprint in revised form of Bulletin 129 of the station on the inspection and care of nursery stock; results of experiments to study the effects of shading and liming tobacco on the prevalence of diseases and the yield and quality of the crop; notes on the so-called "grain" of wrapper tobacco considered due to deposits of oxalate of lime, and on the pole burn of tobacco due to fungi; results of a test of fertilizers applied in small quantities from time to time throughout the growing season for the prevention of the wilt disease of muskmelons; a discussion of the nature and prevention of raspberry anthracnose, with the results of some experimental work; notes on the downy mildew of melons, a destructive disease of potatoes, injury to peas, leaf spot of alfalfa, and a disease of peppers; a report of progress on experiments in fertilizing peaches with ashes and different amounts of muriate and sulphate of potash and cotton-seed meal; an account of experiments in 1899 similar to earlier work in curing tobacco in a barn provided with hot-air flues and in fermenting Connecticut tobacco in bulk; a determination of the area of leaf surface on the topped tobacco plant; results of tests for vitality of 291 samples of seeds, chiefly of garden vegetables; and chemical studies of the nucleic acid of the embryo of wheat and its protein compounds, the proteids of the egg yolk, and the protein constituents of egg white. Brief reports of the director and board of control on station work during the year, and a financial statement for the year ended September 30, 1899, accompany this part of the annual report.

Annual Report, 1900, Parts I, II, and III, pp. 395, pls. 16, figs. 12.—Part I includes fertilizer statistics for 1900, the text and an abstract

of the State laws relating to fertilizers, notes on the sampling and collecting of fertilizers, explanations regarding the analysis and valuation of fertilizers, a report on determinations of the solubility of organic forms of nitrogen in pepsin-hydrochloric acid, and tabulated analyses and valuations of 466 samples of fertilizing materials. Part II contains the text of the Connecticut food law and the law regulating the sale of commercial feeding stuffs, detailed results of the examination of 824 samples of foods, condiments, water, etc., with notes on methods of examination in some cases; a botanical study of the corncob with special reference to the detection of ground cobs in wheat or rye bran, and a description of a micro-polariscope for food examination. Part III includes an account of extensive spraying experiments with Bordeaux mixture of different strengths, soda-Bordeaux mixture, ammoniacal copper carbonate solution, copper acetate, and potassium sulphid to test the effect of these fungicides upon peach foliage; a provisional bibliography of the more important works published by the United States Department of Agriculture and the agricultural experiment stations of the United States from 1887 to 1900, inclusive, on fungus and bacterial diseases of economic plants; results for 1900 of plat experiments in the greenhouse with lettuce and carnations, in which several soils and various commercial fertilizers were compared; a brief description of a vegetation house arranged for carrying out pot experiments; an account of a test made in continuation of earlier work of the proper time for setting chestnut scions in Connecticut, and of the value of native sprouts as stocks upon which to graft the European and Japanese varieties; a brief report on experiments with hydrocyanic-acid gas in barn and greenhouse; notes on the banding of trees to prevent injury by the fall cankerworm; miscellaneous notes on insects and insecticides; an account of an experiment to determine if wrapper leaf tobacco of the Sumatra type can be grown in Connecticut; a reprint with minor changes of Bulletin 131 noted above; data for a fertilizer experiment with peaches; and reprints of Bulletins 132 and 133 of the station noted above.

GENERAL OUTLOOK.

The experiments last year in growing Sumatra tobacco in the shade were so successful that this year about 42 acres have been grown in the shade in Connecticut. In these investigations the station is coöperating with the Bureau of Soils of this Department and with the Connecticut Tobacco Experiment Company at Poquonock. The experiments in grafting chestnuts have met with severe reverses from fire, but have been successful in demonstrating that the best time for grafting in Connecticut is about the middle of May. The work in forestry and in the protection of shade and fruit trees is attracting favorable attention throughout the State. For the forestry experiments the station has

used part of the proceeds of the William R. Lockwood bequest in purchasing waste land at Poquonock. This work, the inspection work, attendance at farmers' meetings, and cooperative experiments in different parts of the State have aroused more than usual interest among the farming population.

Storrs Agricultural Experiment Station, *Storrs.*[a]

Department of The Connecticut Agricultural College.

GOVERNING BOARD.

Board of Trustees: Gov. George P. McLean (*ex officio Pres.*), *Hartford;* W. E. Simonds (*V. Pres.*), *Hartford;* George A. Hopson (*Sec.*), *Wallingford;* W. D. Holman (*Treas*), *West Willington;* E. S. Henry, *Rockville;* M. M. Frisbie, *Southington;* Edmund Halladay, *Suffield;* E. H. Jenkins, *New Haven;* Geo. S. Palmer, *Norwich;* B. C. Patterson, *Torrington.*

STATION STAFF.

R. W. Stimson, M. A., *Acting President of the College.*
W. O. Atwater, Ph. D., *Dir.* (*Middletown*).
C. S. Phelps, B. S., *V. Dir.; Agr.*
F. E. Singleton, *Sec.* (*Middletown*).
H. W. Conn, Ph. D., *Bact.* (*Middletown*).
W. A. Stocking, jr., B. S. A., *Dairy Experimenter.*
W. M. Esten, M. S., *Asst. in Dairy Bact.* (*Middletown*).

LINES OF WORK.

The work of the Connecticut Storrs Station during the past year has included inquiries in regard to the nutrition of plants, animals, and man, and the bacteriology of the dairy. In connection with the investigations relating to the nutrition of plants, the station has continued rotation tests to study the deficiencies of the soil and the needs of the different crops for the different ingredients of fertilizers; pot and field experiments with corn, cowpeas, soy beans, and other crops for studying the effect of nitrogen in different quantities and combinations upon the yields and composition of the crops; and experiments in soil improvement for the purpose of comparing the relative economy of stable manure, a complete chemical fertilizer, and green manures, alone and in combination with mineral fertilizers, for improving a soil apparently deficient in organic matter and in available nitrogen; and has started a new rotation experiment to study the effects of nitrogenous fertilizers on yields and chemical composition of some of the more common forage crops. The inquiries relating to the nutrition of animals have included an investigation on the rations fed to milch cows by farmers and dairymen in the State, and the effects of the feeding upon milk production. The bacteriological investigations have included a study of the bacteria of the dairy and

[a] Telegraph address, *Storrs via Willimantic;* railroad station, express, and freight address, *Eagleville.*

an investigation on tuberculosis in cows, and the use of the milk of tuberculous cows in feeding calves. The investigations on the food and nutrition of man have included the analysis of food materials, studies of dietaries of different classes of people, digestion experiments with men, determinations of fuel values of food materials by means of the bomb calorimeter, and experiments with men in the respiration calorimeter.

The investigations on the food and nutrition of man have, as heretofore, been aided by special appropriation by the State and are carried on in connection with similar investigations conducted under the auspices of this Office (see p. 437). These investigations, and also the bacteriological investigations have been carried on in Middletown, Wesleyan University giving the use of its laboratories for the purpose. The bacteriological work has been placed in charge of Prof. H. W. Conn, of Wesleyan University, who has been made a member of the station staff and who will direct most of his investigations to the application of bacteriology to dairying. Professor Conn has recently published an important manual on agricultural bacteriology. The new dairy building at Storrs affords better facilities for the station, and dairy work at this place will be considerably extended. Two members of the station staff have assisted at farmers' institutes.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$7,500.00
State appropriation	1,800.00
Farm products	115.70
Miscellaneous	12.50
Total	9,428.20

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 22 and the Annual Report for 1899.

Bulletin 22, pp. 20.—The Soy Bean as a Forage and Seed Crop.— A popular discussion of the culture and uses of this crop based largely upon the results of work at the station.

Annual Report, 1899, pp. 223.—This contains a financial statement for the fiscal year ended June 30, 1899; a report of the director reviewing the work of the station during the year; detailed descriptions, including morphology and cultural and biochemical characteristics, of over 100 species of bacteria isolated from dairy products

during the last ten years, together with an account of the collection of the bacteria, methods of isolation and study, and the classification and naming of the species; discussion of the terms digestibility, availability, and fuel value; a discussion based upon the results of nutrition investigations carried on under the auspices of this Department of the proportion of nutrients supplied by different groups of food materials in the average diet, the availability of different classes of nutrients in food of mixed diet, heats of combustion of nutrients, fuel value, and related topics; tables showing the available nutrients in a large number of animal and vegetable foods; detailed reports of dietary studies with college students, a chemist's family, and a chemist; full data concerning the history of four tuberculous cows and of calves fed upon their milk, with a general summary of the results and practical deductions; results for three years of experiments on corn, cowpeas, and soy beans, to determine the effects of nitrogen in different quantities and combinations; results of a rotation soil test planned to study the deficiencies of soils and the fertilizer requirements of different crops; a brief account of experiments begun in 1899 to test the relative value of stable manure, a complete chemical fertilizer, and green manures, alone and in combination with mineral fertilizers, as means of improving worn-out soils; tabulated analyses of fodders and feeding stuffs; and a monthly summary of meteorological observations during 1899.

GENERAL OUTLOOK.

Among the more important needs of agriculture in the State is a clearer knowledge of the principles of nutrition of both plants and animals. Intensive cultivation of crops and expert management of herds are more and more indispensable to successful farming. It is the effort of the station, therefore, to furnish information concerning these matters. The field experiments are made for the special purpose of studying the particular needs of different soils and crops and the best methods of supplying them with fertilizers. Experiments are also being made to learn the best method of restoring fertility to soils that have long been under cultivation and are lacking in some of the ingredients of plant food. In two lines of investigation—the nutrition of animals and man, and dairy bacteriology—the Storrs Station has done a relatively large amount of high grade work, the results of which are favorably regarded both in the United States and in Europe.

DELAWARE.

The Delaware College Agricultural Experiment Station, *Newark.*

Department of Delaware College.

GOVERNING BOARD.

STATION STAFF.

Geo. A. Harter, M. A., Ph. D., *President of the College.*

Arthur T. Neale, M. A., Ph. D., *Dir. and Agr.*
F. D. Chester, M. S., *Myc.*
C. P. Close, M. S., *Hort.*
C. L. Penny, M. A., *Chem.*
W. H. Bishop, B. S., *Met.*
H. B. Eves, V. M. D., *Vet.*
E. Dwight Sanderson, B. S. A., *Ent.*

LINES OF WORK.

The work of the Delaware Station during the past year has been along the same general lines as heretofore, including chemical studies of soils and sugar beets and sorghum, bacteriological studies of soils, field experiments with sugar beets, varieties of sorghum, and forage crops, especially cowpeas and corn grown with cowpeas; feeding experiments; dairy investigations; studies of diseases of animals and plants; horticultural investigations, principally with the sour cherries of America, apples, and pears; entomological investigations, including studies of injurious insects and experiments with various insecticides and different kinds of apparatus for applying the same. The station is cooperating with the Bureau of Plant Industry of this Department in experiments with cover crops for orchards, and with the Bureau of Chemistry of this Department in studies of the influence of environment on the sugar content of muskmelons.

Two wings are being added to the main college building and the building is being otherwise remodeled. The cost of the improvements will be at least $25,000. The entomologist of the station will have rooms in one of the new wings, and another room will be especially fitted up for photography. These changes will give more room in the station building for the officers who remain there. Farmers' institutes are managed independently by the three counties in the State, each of which receives from the State $200 a year for this purpose, but members of the station staff assist in conducting the meetings. At the close of the fiscal year the horticulturist resigned to accept a position in the Bureau of Plant Industry of this Department, and was succeeded in September by Prof. C. P. Close, of the Utah Agricultural College and Station.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15, 000

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 47–52 and the Annual Reports for 1899 and 1900.

Bulletin 47, pp. 30, figs. 12.—Common Diseases of Fowls; Their Control and Treatment.—A general account of the etiology, symptoms, and treatment of the common diseases of poultry.

Bulletin 48, pp. 16, figs. 12.—Top-working Apple Trees.—A popular discussion of the methods and advantages of top-working apple trees.

Bulletin 49, pp. 24, pls. 2, figs. 7.—The Strawberry-root Louse.—The Destructive Pea Louse in Delaware.—Economic and biologic notes on the strawberry-root louse and the destructive pea louse, with a discussion of preventive and remedial measures.

Bulletin 50, folio, figs. 8.—Directions for Treatment of Insect Pests and Plant Diseases.—Brief notes on the common insect enemies and fungus diseases of the more important economic plants, with formulas for making the standard insecticides and fungicides.

Bulletin 51, pp. 24, figs. 5.—Pedigreed Sorghum as a Source of Cane Sugar.—This bulletin gives a comparison of sugar cane, sugar beets, and sorghum as sources of sugar, describes a method of raising sorghum, points out how its value for sugar production is determined, and discusses the machinery needed to extract sorghum sugar, with estimates of its cost and suggestions as to its management.

Bulletin 52, pp. 8, figs. 7.—Pear Blight and Pear Canker.—A discussion of this subject reprinted from the Annual Report of the Station for 1900.

Annual Report, 1899, pp. 257, pls. 2, figs. 29, dgm. 1.—This includes a financial statement for the fiscal year ended June 30, 1899; the organization list of the station; summarized and detailed reports of the work of the different departments during the year; reprints of Bulletins 42, 44–46 of the station; results of fertilizer experiments with basic slag, ground bone, and acid phosphate on rye and grass; results for the fourth year in succession of spraying experiments for the control of apple scab; a report on examinations of cases of suspected anthrax and hog cholera and on tests of commercial hog-cholera serum; studies in systematic bacteriology, including an outline for the study of the subject and a synopsis of the groups of bacteria; descriptions of 9 species of bacteria isolated from cultivated soils, 6 of which are given as new; observations on the chemical functions of certain soil bacteria, including the production of ammonia and the reduction of nitrates to nitrites and the relation of the growth of these organisms to the reaction of the media; data obtained in thinning experiments with plums; an account of spraying experiments with Bordeaux mixture for the prevention of tomato blight; results of tests of several remedies against strawberry-root aphis; observations on the effect of hydrocyanic-acid gas upon strawberry plants; and monthly summaries of meteorological observations during the year.

Annual Report, 1900, pp. 259, pls. 7, figs. 48.—This contains a financial statement for the fiscal year ended June 30, 1900; the organi-

zation list of the station; and departmental reports. The report of the agriculturist includes an account of the development of a dairy herd at the station and a reprint of Bulletin 51 noted above. The report of the mycologist contains results of spraying experiments for the treatment of apple scab; notes on pear blight and on canker in apple and pear trees; reports on cases of pneumonia in a calf, asthenia or going-light of fowls, and entero-hepatitis or blackhead of fowls, including the results of bacteriological investigations in connection with the discussion of each disease; and an account of a bacteriological investigation of drinking water occasioned by a serious outbreak of typhoid fever. The report of the chemist contains an account of work in the selective propagation of sorghum and experiments in planting at different rates, a description of a multiple fat extractor for the rapid determination of fat in milk, a comparison in tabular form of the records of 13 cows belonging to a private herd during 2 lactation periods, and an analysis of a proprietary preparation sold as a "preventive and cure for hog cholera." The report of the horticulturist contains a discussion of the nomenclature of the sour cherries of America and an arrangement of the varieties into 4 groups, the more important varieties under each being described; an account of experiments with Keiffer pears to study the degree of fertility or sterility of the variety, the influence of several different pears used as pollenizers, and the behavior of the variety in different places; and preliminary reports on experiments in thinning Keiffer pears and on pollination experiments with apples. The report of the entomologist contains articles on the strawberry-root louse and the destructive pea louse; biologic and economic notes on a large number of insects injurious to apples, clover, etc.; an account of experiments with crude petroleum as a remedy for the San José scale; and a discussion on hydrocyanic-acid gas as an insecticide for low-growing plants and the diffusion of the gas in an inclosed space. The report of the meteorologist gives monthly summaries of meteorological observations at 6 places in Delaware during 1899 and 1900.

GENERAL OUTLOOK.

The staff of the Delaware Station are doing a relatively large amount of investigational work along lines of practical importance to the agriculture of the State. The director of the station is giving much attention to feeding experiments with heifers for the purpose of finding crops that will furnish protein cheaply. The bacteriologist is making a special study of soil bacteria to determine the relative number of bacteria in different soils and at different depths, the effect of different fertilizers on the number of bacteria in the soil, etc. He has recently published a manual of determinative bacteriology. The entomologist is making special studies of aphids, giving particular attention to the

pea louse and apple lice. He has in press a bulletin giving a summary of information regarding the apple-bud borer, the fruit-tree bark borer, and the 17-year locust; also a book on Insects Injurious to Staple Crops. While most of the members of the staff teach in the college, this work is not made burdensome and they are doing much for the advancement of agriculture in the State.

FLORIDA.

Agricultural Experiment Station of Florida, *Lake City.*

Department of Florida State Agricultural College.

GOVERNING BOARD.

STATION STAFF.

Thos. H. Taliaferro, C. E., Ph. D., *President of the College and Director.*
Horace E. Stockbridge, Ph. D., *Agr.*
H. K. Miller, M. S., *Chem.*
H. A. Gossard, M. S., *Ent.*
H. Harold Hume, M. S., *Bot. and Hort.*
Chas. F. Dawson, M. D., D. V. S., *Vet.*
A. W. Blair, M. A., *Asst. Chem.*
W. P. Jernigan, *Auditor and Bookkeeper.*
John F. Mitchell, *Foreman of Farm.*
J. H. Jefferies, *Foreman of Garden and Orchards.*
Lucia McCulloch, *Asst. Biol. and Asst. Libr.*
Minnie Helvenston, *Sten. and Libr.*

LINES OF WORK.

The work of the Florida Station during the past year has included three principal lines—culture and fertilizer experiments with the staple crops of the State, investigation of the diseases and insect pests of the leading fruits and vegetables, and feeding experiments. The culture and fertilizer experiments have been with forage crops, cassava, sugar cane, sweet potatoes, pecans, pineapples, and citrus fruits. In this connection, also, chemical investigations of water, pineapple soils, and fertilizers have been made. Among plant pests and diseases the white fly and the tent method of repression, scale insects, and diseases of cucumbers, cantaloupes, lettuce, and potatoes have been subjects of special study. Cassava, velvet bean, and the beggar weed have been used in combination with cotton-seed meal, corn, hay, etc., in digestion experiments with steers and cows, and the feeding experiments with razor-back pigs have been continued. Extensive experiments with pineapples, which were given up a year ago, have been resumed recently.

The Florida Station is studying methods of analyzing phosphoric acid and pineapples in cooperation with the Bureau of Chemistry of this Department, and conducting experiments with hybrid oranges in

cooperation with the Bureau of Plant Industry of this Department. The Bocaraton fruit plantation is well started, having been planted about a year ago to different kinds of citrus fruits, on which a resident superintendent directed by the station horticulturist will conduct fertilizer experiments and experiments in renderiug citrus fruits dormant so as to resist frost. The land in charge of the station near Lake City will henceforth be used for rotation and pasture experiments and the growing of forage for feeding experiments. The legislature of the State at its last session appropriated $5,000 for the support of a veterinary department for the college and station during the next two years, $5,000 for farmers' institutes, and $10,000 for a model farm to be conducted by the college. Dr. Charles F. Dawson, formerly of the Bureau of Animal Industry of this Department, has been appointed veterinarian. During the year Dr. W. F. Yocum, president of the college and director of the station, resigned, and Dr. T. H. Taliaferro, formerly of Pennsylvania State College, has been appointed to succeed him.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	863.67
Total	15,863.67

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 54, 55, and the Biennial Report for 1899 and 1900.

Bulletin 54, pp. 31, pls. 3, figs. 9.—Pecan Culture.—The botany, methods of propagation and culture, varieties, and the adaptation of pecans to Florida conditions are considered. Some notes on the production of new varieties by crossing are given, and 18 varieties grown either in Florida or Georgia are described.

Bulletin 55, pp. 96, pls. 12, fig. 1, dgm. 1.—Feeding with Florida Feed Stuffs.—The conditions which govern stock feeding in Florida are described, the general principles of feeding are discussed, feeding experiments with steers and pigs in which comparisons were made of different feeding stuffs are reported in detail, and the results of an experiment with a steer to determine the digestibility of cassava are given.

Biennial Report, 1899 and 1900, pp. 76, pls. 4, figs. 9.—This contains a report of the director reviewing the different lines of station

work and giving notes on the station staff and station equipment; financial statements for the fiscal years ended June 30, 1899 and 1900; a report of the agriculturist giving results of various culture and fertilizer experiments; a report of the chemist summarizing the work of the department during the two years; a report of the botanist and horticulturist giving a brief account of citrus experiments under way, pecan culture in Florida, and of three native plants for decorative purposes—the Atamasco lily, sparkleberry, and sumac; descriptive and historical notes on the downy mildew of the cucumber, with the results of experiments conducted for the repression of this disease; notes on three diseases of celery, with suggestions as to treatment, and a list of about 70 species of fungi collected in Florida; and a report of the entomologist giving notes on a large number of insects observed during the two years, with the results of several experiments for their repression.

GENERAL OUTLOOK.

The station management is directing its efforts toward the development of the fruit industry, cattle raising, and dairying. The pineapple industry is growing rapidly and presents several troublesome problems which the station should endeavor to solve. Among these problems is that of discovering a remedy for root blight, which is very troublesome, and that of keeping the land in good condition for this crop. There is need of a thorough study of the physical and other conditions of pineapple soils. Citrus fruits and sugar cane are also important crops and are receiving considerable attention from the station. The feeding experiments and the rotation and fertilizer experiments with forage crops have been conducted with a view to developing the cattle-raising industry, especial efforts being directed toward obtaining breeds of cattle thoroughly adapted to the Florida climate, both for beef and dairy purposes. The recent appropriations made by the legislature will enable the station to considerably extend its usefulness in veterinary science, and also to develop the farmers' institute movement which the college has been carrying on unaided for several years. The increased liberality of the State to this institution is very encouraging, and will, it is hoped, favorably affect the station in a number of ways. Owing to the fact that the college is located outside of the chief fruit-growing region of the State, it is very desirable that the experiments in other localities, especially those with pineapples and citrus fruits, should be put on a thoroughly efficient basis. For this purpose it is essential that the officers in charge of this work should be in a position to be absent from Lake City whenever the needs of their experimental work elsewhere demand.

GEORGIA.

Georgia Experiment Station, *Experiment.*[a]

Department of Georgia State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Directors: O. B. Stevens (*Pres.*), *Atlanta;* J. B. Park, jr., (*Sec. and Treas.*), *Greensboro;* Walter B. Hill, *Athens;* H. C. White, *Athens;* G. M. Ryals, *Savannah;* P. E. Boyd, *Leary;* J. T. Ferguson, *Leesburg;* J. H. Mobley, *Hamilton;* A. J. Smith, *Conyers;* N. B. Drewry, *Griffin;* Felix Corput, *Cavespring;* John Deadwyler. *Maysville;* John Gilmore, *Warthen;* William Henderson, *Ocilla.*

STATION STAFF.

H. C. White, C. E., Ph. D., *President of the College.*
R. J. Redding, *Dir.*
H. C. White, C. E., Ph. D., *V. Dir.; Chem.*
S. H. Fulton, B. S., *Biol. and Hort.*
J. M. Kimbrough, *Agr.*
Wm. F. Fiske, *Asst. Ent.*
Claude L. Willoughby, *Dairyman.*
Miss J. M. Heyfron, *Sten. and Accountant.*
C. A. Mosier, *Supt. Hort. Grounds.*

LINES OF WORK.

At the Georgia Station the work of the past year has been mostly along the same lines as in former years, including variety, fertilizer, and culture experiments with corn, cotton, fruits, and vegetables; feeding experiments and dairy work, and study of remedies for crown knot, brown rot, and other plant diseases. Considerable attention has been given to experiments in spraying, with special reference to the more general use of this practice in Georgia. Following tests of a large number of varieties of grapes, a new vineyard is being established to include only those varieties found to be desirable for Georgia, and with a view to restricting the work of the station hereafter chiefly to experiments with these varieties. The station has cooperated with this Department in experiments on grasses, races of peaches, fertilizers for melons in southern Georgia, and the spraying of peaches in western Georgia. During the year a new plant house has been completed. A. L. Quaintance, biologist and horticulturist, has recently resigned to accept the position of entomologist in the Maryland Agricultural Experiment Station, and has been succeeded by S. H. Fulton, formerly superintendent of the South Haven, Mich., substation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	750.00
Farm products	2,361.48
Miscellaneous, including balance	2,935.71
Total	21,047.19

[a] Telegraph, express and freight address, *Griffin.*

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 49–52 and the Annual Report for 1900.

Bulletin 49, pp. 56, pl. 1.—Practical Dairying.—This bulletin contains a popular discussion of dairy cows in regard to breed and type; care of cows, stable management, milking, separating and ripening cream, churning, butter making, cheese making, feeding, dehorning, and the calculations of rations; feeding standards and analyses of feeding stuffs; rations suggested for milch cows and for fattening steers; the results of experiments conducted for several years to ascertain the cost of milk and butter production; brief general notes on dairying in Georgia and on the selection of a dairy herd; and suggestions on the destruction of cattle ticks for preventing the development of Texas fever in Northern cattle imported into the South.

Bulletin 50, pp. 37, pls. 3, figs 6.—The Brown Rot of Peaches, Plums, and other Fruits.—Investigations on this disease, due to *Monilia fructigena*, are reported. The life history of the fungus was studied and spraying experiments for the prevention of the disease were conducted.

Bulletin 51, pp. 24.—Corn Culture.—A detailed account of culture, variety, seed, and fertilizer experiments with corn in continuation of similar work previously reported. Weather conditions during the growing season are given.

Bulletin 52, pp. 32.—Cotton Culture.—Variety, seed, culture, and fertilizer experiments with cotton are reported in detail. The tests included mixing the seed of an early and a late variety of cotton, planting at different distances, and a comparison of different methods of applying fertilizers.

Annual Report, 1900, pp. 77, pls. 10.—This includes a report of the director on the publications and work of the station during the year; a financial statement for the fiscal year ended June 30, 1900, and a report of the biologist and horticulturist, containing notes on different varieties of peaches and plums; a report on work with grapes, including a study of the degree of self-fertility and a test of the keeping qualities of different varieties; a study of the effects on the fruit of ringing grapevines; a comparison of methods of training, and analyses of different varieties with reference to the sugar content of the juice; results of tests of a number of varieties of cantaloupes, onions, and celery; analyses of 43 varieties of sweet potatoes; notes on the development of the fruit buds of the peach; and rather extended notes on

a large number of the more injurious plant diseases and insects noted by the author during the year.

GENERAL OUTLOOK.

The operations of the station continue to be directed largely to the improvement of cotton and corn, the two staple crops of the State, and yet considerable attention is given to the development of horticultural interests, especially the growing of peaches. The dairy work has been illustrative in nature, but now that the station has demonstrated the suitability of the State for dairying, it is planned to put the work on an experimental basis. The station officers attend horticultural and other meetings, but farmers' institutes as such are not yet organized in the State, though they are much needed.

HAWAII.

Hawaii Agricultural Experiment Station, *Honolulu.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

Jared G. Smith, *Special Agent in Charge.* T. F. Sedgwick, *Agr.*
Frank E. Conter, *Farm Foreman.*

LINES OF WORK.

The work of the Hawaii Experiment Station during the past year has been confined mostly to surveying and clearing land, the erection of buildings, and the organization of a staff. The only experimental work attempted was the inauguration of a cooperative experiment with taro (*Colocasia antiquorum*) for the purpose of studying a blight which causes losses amounting sometimes to as high as 90 per cent of the crop. The station has been called upon for considerable advice by correspondence and has prepared a bulletin on sorehead and other diseases of poultry, which are very troublesome in Hawaii.

INCOME.

The appropriation for the Hawaii Experiment Station for the fiscal year ended June 30, 1901, was $10,000. For the current fiscal year it is $12,000.

GENERAL OUTLOOK.

Subsequent to the visit of Dr. W. C. Stubbs to the Hawaiian Islands as special agent from this Department and the publishing of his report, Mr. Jared G. Smith, of this Department, was appointed special agent in charge of the Hawaii Experiment Station, March 1, 1901. Mr. Smith arrived in Honolulu April 5, and immediately began making preliminary surveys of the land selected by Dr. Stubbs for

the use of the station. This land was formally transferred to the United States June 10, and comprises 154 acres known as the Kewalouka tract in Makiki Valley adjacent to the city of Honolulu. It is nearly 2 miles long and varies in width from about 300 yards at its lowest portion (125 feet above sea level) nearest the city to about 100 yards at the upper end (1,350 feet above sea level).

The work of clearing land and erecting buildings began in May. Two lots were cleared of timber, one of 24 acres near the lower end and one of 13 acres at the upper end of the reservation. In addition 20 acres on the slope above the station buildings were roughly cleared of guava and lantana to allow the grass to grow for pasturage. The buildings erected include an office, a residence containing six rooms, a cottage for laborers, 2-story stable, poultry house, manure shed, and a small storehouse for dynamite. A water system connected with the city water system was installed by the station and tanks were constructed at convenient places for fire protection, irrigation, and other purposes.

At the upper clearing about 1½ acres have been dug over and terraced and a cottage containing two rooms for laborers and a tool room has been erected. This structure is roofed with corrugated galvanized iron which projects 4 feet to give a large surface for collecting rain water. The water thus collected is stored in a large tank which is connected by pipes with the terrace where the water will be used.

Owing to lack of funds it has been impracticable as yet to conduct experiments to any extent on the station farm, but it is the intention to begin experiments with potatoes, corn, tobacco, coffee, and other crops and studies of problems in animal husbandry as soon as possible. Taro is the staple food of the native Hawaiians, hence the experiments to discover a method of protecting it from blight are considered of great immediate importance. Investigations are being made of the agricultural conditions in the different islands, with a view to planning the future operations of the station to meet the needs of different regions.

Hawaiian Sugar Planters' Experiment Station, *Honolulu.*

GOVERNING BOARD.

Trustees of Hawaiian Sugar Planters' Association.

STATION STAFF.

C. F. Eckart, *Dir. and Chem.*
S. S. Peck, B. S., *Asst. Chem.*
E. J. Lea, B. S., *Asst. Chem.*
E. G. Clarke, *Field Asst.*

The work of this station during the past year has been confined closely to investigations bearing on the sugar industry in its various branches. These investigations involve studies of the fertilizer requirements of different soils, irrigation investigations, physical and

chemical analyses of soils, variety tests, fertilizer and culture experiments with sugar cane, and studies of the technology of sugar manufacture.

The station has been maintained as heretofore by the Sugar Planters' Association. The director, R. E. Blouin, has recently resigned to return to the station at New Orleans, and has been succeeded by C. F. Eckart, formerly first assistant chemist of the station.

IDAHO.

Agricultural Experiment Station of the University of Idaho, *Moscow.*

Department of the University of Idaho.

GOVERNING BOARD.

Board of Regents: John B. Goode (*Pres.*), *Rathdrum;* Mrs. Wm. H. Ridenbaugh (*V. Pres.*), *Boise;* Geo. C. Parkinson (*Sec.*), *Preston;* George W. Chapin, *Idaho Falls;* Henry E. Wallace, *Caldwell.*

STATION STAFF.

J. A. McLean, Ph. D., *President of the University and Director.*
Louis F. Henderson, Ph. B., *Bot.*
John M. Aldrich, M. S., *Ent.*
John E. Bonebright, M. A., *Met.*
Fred A. Huntley, B. S. A., *Hort.*
Hiram T. French, M. S., *Agr.*
Chas. A. Peters, B. S., Ph. D., *Chem.*
Chas. N. Little, M. A., Ph. D., *Irrig. Engin.*
Hal. T. Beans, M. S., *Asst. Chem.*
Herbert T. Condon, *Clerk.*
William L. Payne, *Treas.*

LINES OF WORK.

The work of the Idaho Station during the past year has included feeding experiments with steers and lambs; experiments with tame grasses to determine their value for pasturage, and with clover and a number of grasses for hay; tests of the yield and growth of barley, corn, macaroni wheats, soy beans, broom-corn millet, spelt, and Russian grains; botanical work, including studies of mushrooms and the fungus diseases of the grape, peach, and pear, and experiments with different spraying materials; chemical investigation of insecticides and fungicides; analysis of soils, feeding stuffs, prunes, ores, and miscellaneous articles; study of the nitrogen content of wheat; sugar-beet investigations; studies of the San José scale, elm louse, pear-leaf blister mite, grasshoppers, and other insects; spraying experiments with insecticides; horticultural investigations, including experiments in the cultivation and pruning of fruit trees, the use of barnyard manure in the production of root crops, experiments in growing garden vegetables with and without irrigation, and experiments in root pruning to hasten the ripening of beans; meteorological observations.

The feeding experiments have been conducted with a view to encouraging animal production in a region where continuous wheat raising has been practiced almost exclusively. Already considerable

interest has been aroused in this and in the growing of forage plants and grasses for the purpose. In this connection experiments are being made with different kinds of pasture grasses and clovers for sheep, the sheep being hurdled on small tracts. The sugar-beet investigations have included cooperative experiments with 80 farmers in the Payette Valley, an irrigated district in southern Idaho, for the purpose of testing the economic value of the sugar beet in that region. In May of the present year phylloxera was discovered on grapevines at Julietta and prompt quarantine measures were taken. The station has begun investigations of the codling moth in cooperation with the Division of Entomology of this Department. The State has given the university $50,000 for the erection of a girls' dormitory and a science hall, and $1,000 a year for two years to support farmers' institutes. During the year a piggery (Pl. II, fig. 2) was erected on the station farm and other minor improvements were made. In the department of chemistry Dr. Charles A. Peters succeeded Dr. Avery, and in that of irrigation engineering Dr. Charles N. Little, late of Leland Stanford Junior University succeeded Arthur P. Adair.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000
Farm products	1,500
Total	16,500

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 24–27.

Bulletin 24, pp. 18.—Cattle Feeding.—Crop Tests.—A feeding experiment with 12 steers, to determine the profit in fattening steers, under local conditions, is reported, and notes and tabulated data are given on the culture and test of varieties of potatoes, millet, and rape at the station.

Bulletin 25, pp. 11.—The Composition of Arsenical Insecticides.—Results of analyses of 19 samples of Paris green obtained from dealers in different parts of the State, with notes on various other arsenical insecticides.

Bulletin 26, pp. 12.—Crude Petroleum.—The Elm Louse.—The Pear-leaf Blister Mite.—Spraying experiments with crude petroleum for the destruction of San José scale and plant lice are reported and

directions given for the preparation of crude petroleum emulsion, and notes are given on the life history and habits of the elm aphis and the pear-leaf blister mite, with the results of experiments for their destruction.

Bulletin 27, pp. 40, pls. 10.—fig. 1.—Mushrooms or Toadstools.—Descriptions are given of a number of the more common mushrooms, with directions for their identification. Notes are given on the value of mushrooms as food, and a number of recipes for preparing them for the table, taken from various sources, conclude the bulletin.

GENERAL OUTLOOK.

In Idaho, as in other Western States where the single-crop method of farming largely prevails, the introduction of greater diversity by demonstrating the adaptability of the region to the production of live stock, fruit, and untried field crops, is work of the greatest immediate importance, and such is the principal work of this station. Corn is a crop that it was supposed would not ripen in northern Idaho, but after repeated efforts the station has succeeded in finding a variety that will mature. Sugar-beet production is being encouraged by cooperative experiments in southern Idaho, and plans have been made for conducting more extensive irrigation experiments in the same region. The station has succeeded in arousing considerable interest in stock feeding among the farmers, and a number of them are taking up stock raising. During the year 6 members of the staff have engaged in farmers' institute work, and in spite of the scattered population and the difficulties of travel, encouraging meetings were held and considerable interest in the work of the station aroused. It is encouraging to find that this work is sufficiently appreciated to have the State legislature make a special appropriation for its future maintenance. This station should be organized more definitely as a distinct department of the university and be placed in immediate charge of an expert director, with a view to concentrating its efforts on a few lines of great importance to the agriculture and horticulture of the State and pushing its investigations energetically in accordance with a well-considered plan.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, *Urbana.*

Department of the University of Illinois.

GOVERNING BOARD.

STATION STAFF.

Andrew S. Draper, LL. D., *President of the University.*

Eugene Davenport, M. Agr., *Dir.*
T. J. Burrill, Ph. D., *Bot.*
S. A. Forbes, Ph. D., *Ent.*
D. McIntosh, V. S., *Vet.*
C. G. Hopkins, Ph. D., *Agron. and Chem.*
J. C. Blair, *Hort.*
H. W. Mumford, B. S., *Animal Husb.*
W. J. Fraser, B. S., *Dairying.*
G. P. Clinton, M. S., *Bot.*
A. D. Shamel, B. S., *Farm Crops.*
L. H. Smith, B. S., *Chem.*
J. W. Lloyd, B. S. A., *Hort.*
H. E. Ward, M. S., *Chief Asst. in Soil Bact.*
A. J. Glover, B. Agr., *Chief Asst. in Dairy Husb.*
W. H. Knox, M. S., *Chief Asst. in Soil Phys.*
C. F. Hottes, Ph. D., *Asst. in Bot.*
J. H. Skinner, B. S., *Asst. in Animal Husb.*
A. V. Stubenrauch, B. S., M. S. A., *Asst. in Hort.*
H. Hasselbring, B. S., *Asst. in Veg. Path.*
J. H. Petitt, Ph. B., *Asst. in Chem.*
E. M. East, B. S., *Asst. in Chem.*
C. P. Bull, B. Agr., *Asst. in Farm Crops.*
R. S. Woodrow, *Field Asst. in Sugar Beet Investigations.*
Kate McIntyre, *Sec.*
F. H. Rankin, *Institute Visitor.*

LINES OF WORK.

The work of the Illinois Station during the past year, as heretofore, has included investigations in agronomy, horticulture, chemistry, botany, entomology, and animal industry and dairying. The work in agronomy has included rotation and fertilizer experiments to study the needs of the soils, soil inoculation experiments, experiments in selecting corn to improve the protein and fat, and sugar-beet investigations. In horticulture the principal work has been with the apple, and has included the cultivation of orchards, spraying, tests of spraying machinery, experiments with new insecticides and fungicides, pruning work at the station and in private orchards, renovation experiments in an old orchard near the station, and the use of commercial fertilizers and cover crops in the orchard. There have also been experiments with pears and garden vegetables, cold-storage investigations, and studies of the causes that determine quality in muskmelons. The chemist has cooperated with the other departments in studies on corn and muskmelons. The botanist has studied the bitter rot of apples, pear blight, and other diseases of fruits. The entomologist is studying particularly the insects that cause damage to the appearance of fruits and those injuring shade trees. In the latter work he has a man engaged in the parks of Chicago. Work in dairying has been continued along the same lines as formerly, but plans are being made for enlarging this and other work in animal husbandry.

The State legislature of 1900–1901 made liberal appropriations for the college of agriculture and the experiment station, increasing the funds available for agricultural education and research by $60,000 annually, besides making a special appropriation of $10,000 for equipping the new agricultural building. Of the former sum the college of agriculture received $8,000 for the purchase of live stock and $6,000

for additional instruction, and the station received $46,000 for special investigations, as follows: $16,000 for investigations in animal husbandry, including feeding experiments; $10,000 for experiments with corn; $10,000 for soil investigations; $10,000 for orchard work, including the study of insect pests and fungus diseases; $5,000 for dairy investigations, and $3,000 for sugar-beet investigations. The law making the above appropriations provides for the appointment, by certain farmers' associations, of committees to confer with the director of the station on the lines of work to be undertaken, but these committees have no power to dictate as to the details of the investigations. The purpose of the promoters of the measure was to secure cooperation between the farmers and the station, and this feature has been given prominence in organizing the work. Investigations of present conditions of agriculture in the State will be followed by cooperative experiments and demonstration work in different parts of the State, while at the same time the staff is engaged in research work at the station.

In providing the organization to undertake this additional work no new departments were created, but 12 additions to the staff were made. Prof. H. W. Mumford, formerly professor of agriculture in the Michigan Agricultural College, was made chief of the department of animal husbandry, to relieve the director of the details of this work. He will devote his attention to cattle, while an assistant will take up work with horses. In the departments of agronomy, horticulture, botany, and dairy husbandry numerous changes and additions were made, all being along the line of greater specialization. Each department is given a stenographer and record keeper, and considerable attention is being given to systematizing the keeping of records. The large amount of cooperative work contemplated necessitated the appointment of some one to look after the interests of the station in different parts of the State, and Mr. F. H. Rankin was appointed institute visitor to act in this capacity. From the nature of their work other members of the staff also are compelled to spend much of their time away from the station. The advisory board of the station has been abolished. A new feature in the means for disseminating information is a series of circulars which are prepared from time to time and distributed.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	350.00
Farm products	344.93
Balance from previous year	663.46
Total	16,358.39

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 60–65 and the Annual Report for 1900.

Bulletin 60, pp. 135, pls. 9, figs. 97.—The Economic Entomology of the Sugar Beet.—Brief compiled accounts of the habits, life histories, and means of combating about 150 species of insects known to attack sugar beets in the United States, with a bibliography of the subject.

Bulletin 61, pp. 16, pl. 1, figs. 5.—The Farmer's Vegetable Garden.—An account of the cost, care, and production of a small garden planted at the station and well cared for throughout the season.

Bulletin 62, pp. 12.—The Market Classes of Horses.—Road, carriage and coach, cab, bus, and draft horses and trotters are described and their uses pointed out.

Bulletin 63, pp. 28, pls. 12, fig. 1, map 1.—Seed Corn and Some Standard Varieties for Illinois.—This bulletin treats of the necessary qualities of seed corn, presents a list of the various characteristics of corn by which varieties may be systematically studied, and describes a number of varieties adapted to Illinois conditions. Abstracts from the constitution and by-laws of the Illinois Seed Corn Breeders' Association are appended.

Bulletin 64, pp. 16, pls. 6.—Treatment of Oats for Smut.—Notes are given on the amount, nature, and treatment of oat smut, and experiments in treating seed with hot water and formalin are reported.

Bulletin 65, pp. 21, fig. 1.—Construction and Care of Earth Roads.—A popular discussion of this subject under the heads of construction, maintenance, and administration.

Annual Report, 1900, pp. 15.—A brief statement of the principal lines of station work, a subject list of the bulletins issued since the organization of the station, a detailed financial statement for the fiscal year ended June 30, 1900, and the organization list of the station.

GENERAL OUTLOOK.

The past year has been one of reorganization at the Illinois Station. Lines of work already in progress were continued, but the increased facilities and funds for education and research necessitated the reorganization of the different departments and the planning of a large amount of new work. For example, the department of agronomy will undertake breeding experiments with corn and sugar beets, and at the same time greatly extend its investigations in other directions. The department of horticulture will inaugurate cooperative orchard work all over the State, and give more attention than formerly to the

investigation of cold-storage problems. For this latter work one cold-storage house is being erected and three cellars are being refitted, one in the northern, one in the central, and one in the southern part of the State.

No stronger evidence could be shown of the popular favor aroused by the work of the station than the fact that very liberal appropriations were freely made by the legislature last winter. The station now has its work well organized, and with the funds at its disposal is in a position to accomplish very great good for the farming interests of the State. It is very encouraging to have the needs of the experiment station as a research department definitely recognized in the financial budget of the university.

INDIANA.

Agricultural Experiment Station of Indiana, *Lafayette.*

Department of Purdue University.

GOVERNING BOARD.

STATION STAFF.

Winthrop E. Stone, M. A., Ph. D., *President of the University.*
Charles S. Plumb, B. S., *Dir.*
James Troop, M. S., *Hort.*
Henry A. Huston, M. A., A. C., *Chem.*
Joseph C. Arthur, D. S., *Bot.*
A. W. Bitting, D. V. M., *Vet.*
William Stuart, M. S., *Assoc. Hort.*
Herman Dorner, B. S., *Asst. Bot.*
F. S. Johnston, B. S. *Asst. Agr.*
A. N. Hume, *Half-time Asst.*
H. E. Van Norman, B. S., *Dairyman.*
R. C. Obrecht, B. S. Agr., *Supt. Farm.*

LINES OF WORK.

The work of the Indiana Station during the past year has been mainly along the lines noted in previous reports and has included cultural and fertilizer experiments with cereals and forage crops; rotation experiments; vegetation house trials with cowpeas and soy beans in soils inoculated and not inoculated with nitrifying bacteria, and with corn and oats in soils treated with Alinit; experiments with formalin and hot water for smut of wheat; feeding experiments with hogs and dairy cows, including pasturage *v.* no pasturage for the former and soiling *v.* pasturage for the latter; veterinary investigations, especially studies of milk fever, changes in genitive organs during gestation, and sanitary milk inspection; variety tests of fruits and vegetables and cross-fertilization of apples; chemical work, including investigations on the nitrogen-free extracts of feeding stuffs, sugar-beet inves-

tigations, study of losses in curing and keeping corn fodder in the field, and fertilizer experiments with tomatoes. The Indiana fertilizer law, the execution of which is in the hands of the station chemist, has been so amended as to give the chemist complete control of the fertilizer trade. Some investigations have been made on the unproductive soils of the State, which show the need of underdraining, aeration, and fertilizers. The station is cooperating with the Bureau of Chemistry of this Department in sugar-beet investigations, studies on the gluten content of wheat, and an investigation of the influence of environment on the sugar content of muskmelons.

The Indiana legislature has appropriated $60,000 to the university for a new agricultural building which is in process of erection and $10,000 a year for two years for maintenance, besides increasing the fund for farmers' institutes from $5,000 to $10,000 a year. The new agricultural building will not be used by the station, but will indirectly afford the station more room in the building it now occupies. The agriculturist has been relieved of station work to devote himself to teaching and the superintendence of farmers' institutes, and the assistant agriculturist has been appointed to succeed him. The horticulturist has been given an assistant to have charge of work with vegetables, and several other changes have been made which will increase the efficiency of the staff. The veterinarian, on the other hand, has been appointed State veterinarian, which will take considerable of his time from the station.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	2,032.67
Total	17,032.67

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 82–87 and the Annual Report for 1900.

Bulletin 82, pp. 14.—Roots and Other Succulent Food for Swine.—A discussion of the value of succulent materials for the winter feeding of pigs, with the results of tests of the use of sugar beets, artichokes, and purslane for this purpose.

Bulletin 83, pp. 8.—Tests of Small Fruits.—Data for tests of 82 varieties of strawberries, 32 raspberries, 18 blackberries, and 1 dewberry.

Bulletin 84, pp. 28, pls. 3, dgms 3.—Growing Lettuce with Chemical Fertilizers.—A brief review of earlier work and the results of pot experiments with lettuce to compare the efficiency of chemical fertilizers and stable manure, the availability of liquid chemical manures when applied to the surface of the soil and from below, and surface *v.* subwatering.

Bulletin 85, pp. 8.—Chrysanthemum Rust.—Notes on the occurrence of chrysanthemum rust in Indiana, the appearance of the disease, and on experiments to infect related species with this fungus.

Bulletin 86, pp. 8.—On the Amount of Water in Slop Fed Fattening Pigs.—A comparison with 12 pigs of feeding grain dry and mixed with different amounts of water.

Bulletin 87, pp. 26.—Formalin as a Preventive of Oat Smut.—Results of observations and experiments for three years on the use of formalin for the prevention of oat smut, including comparisons of hot water and formalin for this purpose, determinations of the formaldehyde content of commercial formalin, and tests of the effect of formalin treatment on the yield of grain.

Annual Report, 1900, pp. 104, pl. 1, fig. 1.—This contains a report of the director in which the different lines of station work are enumerated; an account of the occurrence and life history of the asparagus rust with suggestions as to treatment; notes on a disease of beets; details and results of experiments on the prevention of loose smut of wheat by formalin and hot water, and the prevention of millet smut by formalin; an account of a study of corn smut made with special reference to the presence of alkaloids, and the physiological effect of smut upon horses; observations on a bacterial disease of tomatoes; statistics on losses from hog cholera and swine plague in Indiana, together with observations on the relation of hog diseases to water supply and to transportation; results of experiments to determine the length of time during which the hog-cholera bacillus may persist in a virulent condition in infected premises, and observations on the relation of the age of swine to the virulence of infection; statistics on the prevalence of sheep scab in the State; a report of 3 outbreaks of rabies affecting dogs, sheep, pigs, horses, and cows; tabulated data and results of fertilizer and culture tests with 12 varieties of tomatoes; a brief statement concerning the distribution of the San José scale in Indiana; analyses of 6 samples of muck and 10 of marl, with a discussion of the occurrence in the State and the utilization of these substances; comparative analyses of normal sugar beets and beets having one or more protuberances on the upper portion of the roots; miscellaneous chemical analyses; results of experiments in sowing clovers at different dates and of culture and variety tests with cowpeas, soy beans, sorghum, and corn; list of exchanges; and a financial statement for the fiscal year ended June 30, 1900.

GENERAL OUTLOOK.

In a number of lines the Indiana Station is investigating problems of vital importance to the agricultural interests of the State. The work with swine is a leading feature of its work, and the swine interests in the State are very large. The station has a good equipment for these investigations and its work is taking a prominent place. Notable among other investigations are those on sugar beets; in veterinary science; the study of unproductive soils, of which there is a large tract; studies of the influence of plant foods on vegetables and on the blossoming of plants, in which line it has done some of its best work. The display of weather signals on the rural free mail-delivery wagons has been introduced by the station and has proven a very popular innovation. The station cooperates in farmers' institute work, which is in charge of the professor of agriculture in the college.

The appropriation for a fine agricultural building, the increase for maintenance, and the increased appropriation for farmers' institute work indicate a growing appreciation of the work of the college and station, and are especially hopeful signs, because the State has heretofore done very little directly for the agricultural department of the university. The station is doing much good work of direct benefit to the farmers and horticulturists in the State, and the present movement toward strengthening the different departments will increase its efficiency.

IOWA.

Iowa Agricultural Experiment Station, *Ames.*

Department of Iowa State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Trustees: Gov. A. B. Cummins, *Des Moines;* R. C. Barrett (*Supt. of Public Instruction*); W. O. McElroy, *Newton;* E. W. Stanton (*Sec.*), *Ames;* Herman Knapp (*Treas.*), *Ames;* W. K. Boardman, *Nevada;* W. J. Dixon, *Sac City;* E. A. Alexander, *Clarion;* C. L. Gabrilson, *New Hampton;* J. B. Hungerford (*Chair.*), *Carroll;* W. R. Moninger, *Galvin;* James H. Wilson, *Menlo;* S. H. Watkins, *Libertyville;* C. S. Barclay, *West Liberty;* W. B. Penick, *Tingley.*

STATION STAFF.

W. M. Beardshear, M. A., LL. D., *President of the College.*

C. F. Curtiss, M. S. A., *Dir.; Agr.*
James Wilson,[a] *Dean of Agr.*
J. B. Weems, B. S., Ph. D., *Agr. Chem.*
L. H. Pammel, B. Agr., M. S., *Bot.*
H. E. Summers, B. S., *Ent.*
W. J. Kennedy, B. S. A., *Animal Husb.*
Joseph J. Edgerton, B. Agr., *Asst. in Agr. Phys.*
C. E. Gray, B. S. Agr., *Asst. Chem.*
John J. Repp, D. V. M., *Vet.*
James Atkinson, B. S. A., *Asst. Agr.*
Jos. E. Guthrie, *Asst. Ent.*
G. L. McKay, *Dairying.*
Homer C. Price, *Hort.*
F. R. Marshall, B. S. A., *Asst. in Animal Husb.*
Miss C. M. King, *Ent., Bot., and Hort. Artist.*
E. E. Little, B. S. A., *Asst. Hort.*
A. T. Erwin, *Asst. Hort.*
Miss A. Estella Paddock, B. S., *Asst. in Bot.*

[a] Granted an indefinite leave of absence.

FIG. 1.—IOWA COLLEGE AND STATION—HORSE BARN AND JUDGING PAVILION.

FIG. 2.—IOWA COLLEGE AND STATION—DRAFT HORSES.

LINES OF WORK.

The principal lines of work at the Iowa Station during the past year have been a continuation of those previously established and have included the selection and development of range-bred horses; feeding experiments with steers, sheep, and pigs; dairy investigations, especially bacteriological studies, fermentation tests, and comparative work with five different breeds of dairy cows; experiments with field crops, including cultural and breeding experiments with corn and various experiments with oats, barley, spring wheat, winter wheat, sorghum, rape, kohl-rabi, soy beans, and sugar beets; horticultural work in hybridizing fruits and testing cover crops for orchards; botanical investigations, especially studies of grasses of the State, fungus diseases of plants, and herbicides for weeds; bacteriological studies of fruits and waters; entomological investigations; chemical analysis of grasses, soils, dairy products, and adulterants of dairy products.

The station is cooperating with the Bureau of Chemistry of this Department in sugar-beet investigations and in testing varieties of wheat sent out by the Department. The botanist is studying the grasses of the State in cooperation with the State geological survey, which publishes the bulletins. He is also making a careful study of the time at which the plum is actually fertilized, it being claimed that there are several weeks during which this may occur. Last spring 250 head of range lambs were purchased and an experiment conducted to determine the practicability of finishing such lambs for the midsummer market. Those that were finished were used to determine results from feeding different grain rations as compared with the results when grass alone was used. Another interesting experiment is that with a bunch of steers which are being fed on condimental foods to test the real value of such material.

Twice within the year the Iowa college and station suffered severely from fire. In December, 1900, part of the main building burned and the divisions of botany and horticulture lost much of their apparatus and scientific collections. In October, 1901, the station barn was destroyed, with a loss of $12,000. The horse barn (Pl. I, fig. 1) recently completed by the college is 40 by 100 feet finished in hard pine, hard maple, and oak, and furnishes accommodations for 25 horses and ample storage room for carriages, harness, grain, and hay. The adjacent stock-judging pavilion is circular in form, 65 feet in diameter, has a seating capacity for 300 students, and a judging pit 50 feet in diameter. At the beginning of the fiscal year Prof. John Craig, horticulturist of college and station, resigned to go to Cornell University and was succeeded in May by Prof. H. C. Price, of the Ohio State University. Prof. John A. Craig, assistant director and animal husbandman, resigned to retire from college work and was succeeded by

Prof. W. J. Kennedy, of Illinois. Prior to his resignation Professor Craig published an important text-book on judging live stock. Several changes occurred also in the staff of assistants.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Farm products	2,951.41
Miscellaneous, including fees	120.64
Total	18,072.05

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 48–55, 57, and 58.

Bulletin 48, pp. 123, pls. 3, figs. 30, dgms. 2.—Economical Production of Beef—A Study of Pork Production—Fattening Range Lambs—Fattening Lambs in Comparison with Yearlings.—Feeding experiments bearing on the general question of producing beef economically under Iowa conditions and extending over a number of years are reported. A test was made with 14 steers to study the possibility of combining dairying and feeding for beef production and also to compare wide and narrow rations. The use of skim milk supplemented by grain was tested in the feeding of these animals as calves. The possibility of fattening range steers with profit on the feeding stuffs generally available locally was tested with 17 steers. The study of pork production here reported included a comparison of different breeds and crosses as regards cost of gain before and after weaning, a comparative trial of wide and narrow rations, a discussion of the value of different breeds for dressed pork and bacon, and chemical studies of the composition of pork. Two tests of the profitable fattening of range lambs and two tests of the comparative economy of feeding lambs and yearlings are reported.

Bulletin 49, pp. 9, figs. 7.—Miscellaneous Insects.—Notes are given on the Buffalo tree hopper, snowy tree cricket, and the box-elder plant bug, with suggestions as to remedies.

Bulletin 50, pp. 13.—Insecticide Methods.—A general account of numerous mechanical and chemical methods for combating injurious insects.

Bulletin 51, pp. 9.—Winter Wheat.—Results of tests of 19 varieties of wheat, several culture experiments, and the milling qualities of hard and soft winter wheat.

Bulletin 52, pp. 31.—Cream Testing—The Influence of Certain Conditions in Churning on the Amount of Water in Butter—A Study of Butter Increasers.—Testing cream by the Babcock method is discussed, suggestions are given for avoiding common sources of error, and investigations of the influence of the thickness of sweet and sour cream upon the amount adhering to the pipette in measuring and of the error resulting from measuring cream due to specific gravity are reported. Investigations made to determine the existence and effectiveness of some of the principles governing the proportion of water in butter, such as size and shape of granules, use of warm water in washing, and the extent of working, are reported. Two methods or recipes for increasing the yield of butter are quoted and the results of an investigation given.

Bulletin 53, pp. 10, pl. 1.—The Asparagus Rust in Iowa.—An account of the asparagus rust in Iowa, the cause of the disease, two parasites of *Puccinia asparagi*, and preventive measures. A brief bibliography of the subject is appended.

Bulletin 54, pp. 286, pls. 39, figs. 106, dgm. 1, chart 1.—Grasses.—Original observations and compiled notes are given on the general characteristics of grasses, their growth and minute structure, fertilization, and germination. The subject of purity and vitality of grass seed is considered. The more important cereals are described. The climatology of grasses is discussed, and notes are given on their uses in medicine. Sugar-producing grasses are enumerated, and notes are given on economic uses of grasses. The poisonous and injurious effects of certain grasses are mentioned. Various fungus diseases are described, and other topics connected with grasses are considered.

Bulletin 55, pp. 25, figs. 7.—Field Experiments.—A detailed account of variety and culture tests with corn, oats, barley, spring wheat, spelt, sorghum, rape, kohl-rabi, soy beans, and sugar beets.

Bulletin 57, pp. 14, pl. 1, figs. 2.—Experiments in Curing Cheese.—Experiments to test the feasibility of central curing rooms and to study the effects of climate upon the curing of cheese are reported. Cheese fresh from the press at the Iowa Station was shipped to cheese factories in Canada to be cured and also from the Canadian factories to the Iowa Station, the scorings being tabulated.

Bulletin 58, pp. 22.—Parturient Paralysis and the Schmidt Treatment.—A general account of the history, distribution, cause, pathological anatomy, symptoms, diagnosis, course, and treatment of this disease, and a summary of the results obtained in the use of the Schmidt treatment as reported by 33 veterinarians. A subject list of station bulletins is appended.

GENERAL OUTLOOK.

The main lines of investigation at the Iowa Station are those in animal industry and agronomy. The experiments with range-bred

colts have been quite successful, and show that fine horses can be developed if good stock be used. Several teams of these horses have been used for station work (Pl. I, fig. 2) and one team for driving. The experiments with dairy cows of five different breeds have been brought to a close and the results prepared for publication. Along the line of field crops the station is having good success in growing winter wheat, and is encouraging its production by farmers. Good results also have been obtained from cutting back oats and winter wheat to prevent lodging. Oats have been found a good nurse crop for clover, and farmers are using it as such upon the advice of the station. The farmers of the State are manifesting a deep interest in the work of the station and are quite generally applying its teachings in their practice. Each summer a farmers' picnic, which attracts farmers from all over the State, is held at the college and station, and this occasion is taken to post the farmers on the work of the college and station.

KANSAS.

Kansas Agricultural Experiment Station, *Manhattan.*

Department of Kansas State Agricultural College.

GOVERNING BOARD.

Board of Regents: J. S. McDowell (*Pres.*), *Smith Center;* F. D. Coburn (*V. Pres.*), *Kansas City;* E. T. Fairchild (*Treas.*), *Ellsworth;* William Hunter (*Loan Commissioner*), *Blue Rapids;* J. M. Satterthwaite, *Douglass;* S. J. Stewart, *Humboldt;* E. R. Nichols (*Sec.*), *Manhattan.*

STATION STAFF.

E. R. Nichols, M. A., *President of College and Chairman of Station Council.*
J. T. Willard, M. S., *Dir.; Chem.*
H. F. Roberts, M. S., *Bot.*
H. M. Cottrell, M. S., *Agr.*
E. A. Popenoe, M. A., *Ent.*
N. S. Mayo, M. S., D. V. M., *Vet.*
Lorena E. Clemons, B. S., *Sec.*
D. H. Otis, M. S., *Dairy Husb.*
F. C. Weber, B. S., *Asst. Chem.*
Albert Dickens, M. S., *Acting Hort.*
V. M. Shoesmith, B. S., *Asst. in Feeding and Field Work.*
A. T. Kinsley, M. S., *Asst. in Vet. Dept.*
J. B. Norton, *Asst. Ent.*
G. O. Greene, B. S., *Asst. Hort.*
Alice M. Melton, *Clerk.*

LINES OF WORK.

The work of the Kansas Station during the past year has been largely a continuation of work reported last year, and has included experiments in the production of "baby beef"—that is, preparation of animals for slaughter at about one year of age; calf raising by various modifications of their feed; feeding a scrub herd of dairy cows especially for a comparison of various kinds of leguminous forage; tests of two prominent condimental feeds as to their effect in the production of beef and milk; experiments in the improvement of blackleg vaccine; tests of the efficacy of "Detmer's virus" in protective inoculation against swine plague; studies of the tetanus bacillus as to

cultural features and the effects of disinfectants; digestion experiments; field experiments on a large scale with soy beans, especially with reference to soil inoculation; cowpeas for hay; thickening the stand of alfalfa, especially the influence of disking after each cutting; variety tests of a large number of grasses and forage plants on a small scale; propagation of some of the native grasses from seed; wheat breeding by cross fertilization; corn breeding with a view to increasing the nitrogen content; study of the relation between specific gravity and nitrogen content of corn; testing of sugar beets grown by farmers of the State; study of native plums and plum breeding by selection and cross fertilization; enlargement of the variety test of apples; study of certain prevalent diseases of orchard and nursery trees, especially the crown gall; the relation of apple rust to red cedar; defoliating fungi of the plum and cherry, and leaf curl of the peach; elaboration of the results of many years' observations upon the trees and shrubs available for lawn and park decoration; studies of plum insects, the apple worm, the cankerworm, and other orchard pests; study of aphids, especially those of the garden vegetables, and the wheat louse; and a review of the entire hemipterous fauna of the State.

In cooperation with the Bureau of Plant Industry of this Department, the station has inaugurated a series of experiments with grasses and forage plants in Harper County, a region of limited rainfall, and also in pasture and range grass improvement. Plans have also been made for cooperative experiments with the Bureau in the origination and testing of varieties of wheat and with the Bureau of Forestry in tree planting. Since the recent fire the chemical department of the station has been very poorly housed and equipped. The State, however, has given $70,000 for a new chemical and physical building which will not only provide quarters for the chemical department of the station, but will enable the director to bring together in one place certain work connected with his office which is now scattered through various college buildings. The agricultural department is renting various pieces of land in the vicinity of Manhattan, but it is expected that a portion of the Government reservation of 7,000 acres at Fort Hays, which has been turned over by act of Congress to the Agricultural College and State Normal School, will soon be available for experimental purposes. The last legislature appropriated $5,000 for the purchase of pure-bred farm stock, and the station has added to its equipment several pieces of valuable apparatus. At the beginning of the present fiscal year the board of regents created a chair of dairy husbandry in the college. During the year the veterinarian resigned to accept a similar position in the North Carolina college, and was succeeded by N. S. Mayo, of the Connecticut Agricultural College, Storrs, who was veterinarian at the Kansas college and station several years ago. The botanist resigned to become assistant agrostologist in this Department, and was succeeded by H. F. Roberts.

INCOME.

The income of the station during the past fiscal year was as follows:

United States' appropriations	$15,000.00
Farm products	5,345.21
Balance on hand July 1, 1900	610.69
Total	20,955.90

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 99–101 and the Annual Report for 1900.

Bulletin 99, pp. 56, fig. 1.—Press Bulletins Nos. 35–70.—This contains reprints of weekly press bulletins issued by the station from April 5, 1899, to June 26, 1900. The articles are based largely upon the results of experiments at the station.

Bulletin 100, pp. 59, pls. 5, map 1.—Soy Beans in Kansas in 1900.—Results of cooperative tests with soy beans reported by 292 farmers in 75 different counties of the State are presented in condensed form, together with the results of culture and variety tests at the station during 12 years.

Bulletin 101, pp. 27, pls. 26, figs. 2, dgms. 2.—Notes from the Plum Orchard.—Notes on the different varieties of European, Japanese, and native plums grown at the station, with illustrations of the more prominent varieties; nursery notes on the growth of several varieties; and a diagram showing the period of blooming and ripening of 24 varieties.

Annual Report, 1900, pp. 187, pls. 18, figs. 19, maps 2.—The report proper contains the organization list of the station, a financial statement for the fiscal year ended June 30, 1900, a general review of the work of the different departments, and a subject list of station publications issued since the organization of the station. Reprints of Bulletins 90–98 of the station are appended.

GENERAL OUTLOOK.

The prominence given to experiments in animal production, to the introduction of drought-resisting forage crops, and to breeding and other experiments with wheat and corn shows an appreciation on the part of the station officials of the relation the station investigations should bear to the principal productions of the State. Station work has been considerably disturbed by changes in the staff, losses by fire, and the large amount of college and farmers' institute work

required of the staff. Press bulletins have been published as heretofore, and the work of the station is becoming better known throughout the State.

KENTUCKY.

Kentucky Agricultural Experiment Station, *Lexington.*

Department of the Agricultural and Mechanical College of Kentucky.

GOVERNING BOARD.

Board of Control: Thos. Todd (*Chair.*), *Shelbyville;* R. S. Bullock (*Treas.*), *Lexington;* J. K. Patterson, *Lexington;* M. A. Scovell, (*Sec.*) *Lexington;* D. F. Frazee, *Lexington;* J. B. Marcum, *Jackson;* J. B. Kennedy, *Paris.*

STATION STAFF.

James K. Patterson, Ph. D., *President of the College.*

M. A. Scovell, M. S., *Dir.; Chem.*
A. M. Peter, M. S., *Chem.*
H. E. Curtis, M. S., *Chem.*
H. Garman, *Ent. and Bot.*
C. W. Mathews, B. S., *Hort.*
J. N. Harper, B. S. *Agr.*
J. W. Nutter, *Asst. Dairy.*
J. O. La Bach, M. S., *Chem.*
W. H. Scherffius, B. S., *Asst. Chem.*
D. W. May, M. S., *Animal Husb.*
L. O. Beatty, M. S., *Asst. Chem.*
George Roberts, M. S., *Asst. Chem.*
S. D. Averitt, M. S., *Asst. Chem.*
T. L. Richmond, B. Agr., *Asst. to Ent. and Bot.*
Miss M. L. Didlake, M. S., *Asst. to Ent. and Bot.*
J. D. Turner, B. Ped., *Sec. to Dir.*

R. M. Allen, B. A., *Clerk.*

LINES OF WORK.

The work of the Kentucky Station during the past year has been continued along the lines of field experiments with tobacco, hemp, potatoes, cereals, etc.; variety tests of grasses and other forage plants; horticultural investigations; studies of plant diseases; entomological and botanical investigations; dairying, especially studies of the variation of butter fat in the milk of cows; meteorological observations; studies of soils, root tubercles, and methods of analysis; and inspection of fertilizers, foods, and nursery stock. Interesting results regarding the root tubercles of soy beans have been obtained; also data that will serve as a guide in determining the time to sow wheat in order to avoid injury from the Hessian fly. Material for publication has been prepared from studies of methods of fumigating stored grains, of mosquitoes occurring in Kentucky, and of hemp insects. The station is cooperating with the Bureau of Chemistry of this Department in experiments on the influence of environment on the sugar content of muskmelons, sugar-beet investigations, and studies of the gluten content of wheat.

The new barn for conducting experiments in curing tobacco has been completed and another farm purchased, which brings the area of the station farm up to 200 acres. A new form of fumigating appa-

ratus, suitable for use in the vivarium with tobacco extracts on low-growing plants, has been devised. During the year the station staff has been increased by the addition of several assistants. At a recent meeting of the board of trustees a division of animal husbandry was created and the erection of a dairy barn authorized. D. W. May, of this Office, has been elected animal husbandman.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation, including balance from previous year	3,123.87
Fees, including balance from previous year	33,054.29
Farm products, including balance from previous year	4,372.31
Miscellaneous, including balance from previous year	110.76
Total	55,661.23

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 86–92 and the Annual Report for 1898.

Bulletin 86, pp. 51.—Inspection and Analyses of Foods.—Analyses of 727 samples of food products made in accordance with the Kentucky pure-food law, with suggested definitions of food materials and articles used in their preparation.

Bulletin 87, pp. 70, pls. 14.—Kentucky Forage Plants—the Grasses.—Analyses of Some Kentucky Grasses.—Notes on 141 species of native and introduced Kentucky grasses, and results of analyses with reference to food constituents of the air-dry and water-free material of 79 samples of grasses cut at different stages of growth and comprising 31 species.

Bulletin 88, pp. 49.—Commercial Fertilizers.—General results of fertilizer inspection, including tabulated analyses and valuations of 361 samples.

Bulletin 89, pp. 24, pls. 4.—Wheat.—Results of fertilizer experiments and of tests of some 30 varieties of wheat, with descriptions and illustrations.

Bulletin 90, pp. 32.—Commercial Fertilizers.—Analyses and valuations of 175 samples of fertilizers inspected during the last half of 1900.

Bulletin 91, pp. 68, pls. 5, figs. 10.—Enemies of Cucumbers and Related Plants.—Experiments with Potato Scab.—The Food of the Toad.—Descriptive, life history, and remedial notes are given on the striped cucumber beetle, spotted cucumber beetle, northern squash

beetle, melon aphis, and a number of other insects affecting cucumbers. A nematode disease of cucumbers is described, and descriptive notes and directions for prevention are given of a number of fungus diseases affecting cucumbers. Experiments in the treatment of seed potatoes with corrosive sublimate and formalin for the prevention of potato scab are reported. Observations on the feeding habits of the toads of Kentucky are given, and the various insects and food materials which were found are classified in detail.

Bulletin 92, pp. 29, pls. 7.—Grapes.—Detailed popular directions for the planting, pruning, training, cultivating, and fertilizing of grapes, with notes on insect ememies and diseases. Descriptive notes are given on 87 varieties of grapes grown at the station.

Annual Report, 1898, pp. 245, pls. 14, figs. 3, maps 3.—This contains a financial statement for the fiscal year ended June 30, 1900; a general review of station work by the director; departmental reports, including analyses of 140 samples of butter, 8 of sorghum, 105 of sugar beets, 19 of mineral waters, and 17 of miscellaneous substances, and a summary of meteorological observations for 1898; and reprints of Bulletins 72–79 of the station.

GENERAL OUTLOOK.

The Kentucky Station is in a prosperous condition. The fees arising from the inspection of fertilizers during the past year amount to over $25,000, and receipts from other sources bring the total revenue of the station up to more than $55,000. This has enabled it to purchase land, erect new buildings, and make other improvements. Furthermore, a division of animal industry has been added, and plans have been made for extending the work in horticulture and for the erection of several new buildings. Heretofore the station has confined its investigations rather closely to lines related to the production and handling of tobacco, hemp, and other staple crops of the State, together with some investigations in dairying, but it is now extending its operations to include other important industries of the State.

LOUISIANA.

No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
No. 2. State Experiment Station, *Baton Rouge.*
No. 3. North Louisiana Experiment Station, *Calhoun.*

Department of Louisiana State University and Agricultural and Mechanical College.

GOVERNING BOARD.

State Board of Agriculture and Immigration: Gov. W. W. Heard, *Baton Rouge;* Wm. Garig (*V. Pres.*), *Baton Rouge;* J. G. Lee (*Commissioner*), *Baton Rouge;* Thos. D. Boyd (*Pres. State University*), *Baton Rouge;* Wm. C. Stubbs (*Dir. State Expt. Sta.*), *Baton Rouge;* Jno. Dymond, *Belair;* Emil Rost, *St. Rose;* A. V. Eastman, *Lake Charles;* E. T. Sellers, *Walnutlane;* Chas. Schuler, *Keatchie;* H. P. McClendon, *Amite.*

STATION STAFF.

T. D. Boyd, *President of the College* (*Baton Rouge*).

Sugar Experiment Station, *Audubon Park, New Orleans.*

Wm. C. Stubbs, M. A., Ph. D., *Dir.*
R. E. Blouin, M. S., *Asst. Dir. Chem.*
P. L. Hutchinson, B. S., *Chem.*
Robert Glenk, B. S., *Chem.*
S. Baum, B. S., *Asst. Chem.*
G. W. Agee, B. S., *Asst. Chem.*
George Chiquelin, *Sugar Maker.*
W. D. Clayton, M. S., *Farm Manager.*
G. D. Harris, M. S., M. A., *Geol.*
Jas. K. McHugh, *Sec. and Sten.*
T. D. Boyd, jr., B. S., *Asst. Chem.*

State Experiment Station, *Baton Rouge.*

Wm. C. Stubbs, M. A., Ph. D., *Dir.*
W. R. Dodson, B. A., S. B., *Asst. Dir.*
H. A. Morgan, B. S. A., *Ent.*
W. H. Dalrymple, M. R. C. V. S., *Vet.*
F. H. Burnette, *Hort.*
B. H. Atkinson, *Farm Manager.*

North Louisiana Experiment Station, *Calhoun.*

Wm. C. Stubbs, M. A., Ph. D., *Dir.*
D. N. Barrow, B. S., *Asst. Dir.*
Maurice Bird, B. S., *Chem.*
J. F. Harp, B. S., *Chem.*
W. R. Goyne, *Farm Manager.*
Eugene J. Watson, *Hort.*
A. T. Anders, *Dairyman and Poultryman.*

LINES OF WORK.

The work of the three Louisiana stations during the past year has been along the same general lines as heretofore, some of the principal subjects of investigation being as follows:

Sugar Station.—Sugar cane has received most attention at this station. Experiments to determine the manurial requirements of this plant, which have been in progress for eleven years, have been continued; also experiments in methods of cultivation, selection, and testing new varieties. In the sugar house have been conducted extensive experiments in clarifying, filtering, evaporating, and cooking, and a series of systematic investigations with artificial mixtures of sugar and other substances to determine the restraining influence of these added substances on the crystallization of sugar. The station is also experimenting with alfalfa, clover, grasses, and other forage crops, varieties of corn, cotton, hybrid orange trees, and tea plants. The inspection of fertilizers and Paris green has been continued as heretofore.

State Station.—Work here has included fertilizer experiments with corn and cotton, rotation experiments to discover a method of restoring the soils of the bluff regions, and investigations with forage crops. Tobacco experiments, as reported last year, have been continued. The veterinarian has demonstrated the usefulness of inoculation for Texas fever in Louisiana and is now studying diseases of sheep. The botanist and bacteriologist has been studying diseases of plants and a process of sterilizing sirups and molasses. There are also feeding

experiments with cattle; variety and fertilizer experiments with pears and other fruits; and entomological investigations, especially on the cane borer, for which a practical remedy has been developed. The new laboratory building has been completed and a large college dormitory building is in process of construction.

North Louisiana Station.—Fertilizer experiments with corn, cotton, and other crops, experiments in the utilization of corn fodder, rotation experiments, tobacco experiments, dairy investigations, study of a nodular disease in the intestines of sheep, and experiments with forage crops and orchard fruits have been the principal lines of investigation at this station. Considerable attention is given to the introduction of improved breeds of live stock and to methods for saving various kinds of fodder.

The Louisiana stations are cooperating with the Division of Entomology of this Department in the investigation of outbreaks of grasshoppers and with the Bureau of Plant Industry of this Department in growing hybrid orange trees. The geological survey of the State has been continued and valuable data have been secured regarding the depth, rate of flow, etc., of artesian wells. The soil survey also has been continued, together with physical and chemical analyses of soils. Farmers' institutes, under the direction of the commissioner of agriculture, assisted by members of the station staff, were held in nearly every parish of the State.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation	$15, 000. 00
State appropriation	18, 000. 00
Fees	2, 350. 03
Farm products	1, 481. 73
Miscellaneous, including balance from previous year	9, 435. 75
Total	46, 267. 51

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 60–63 and the Annual Report for 1900.

Bulletin 60, pp. 30.—Charbon.—A discussion of legislation against this disease and detailed notes on a trip of inspection made through the State for the purpose of determining the extent of anthrax, the conditions under which infection takes place, and the sanitary measures adopted.

Bulletin 61, pp. 67, pls. 13, figs. 10.—Rice.—A discussion of the lands best adapted to this crop; methods of soil preparation, planting, flooding, and harvesting the crop; varieties cultivated in Louisiana; composition of rice and its straw, with data regarding the production of rice in Louisiana; irrigation methods employed, money invested in irrigation plants, and the acreage under irrigation; and an account of the more important weeds occurring in the rice fields of Louisiana, their methods of distribution, and the various means of destruction.

Bulletin 62, pp. 37.—Results for 1899 at North Louisiana Experiment Station.—Brief notes on the live stock kept at the station; results of various culture, variety, and rotation experiments with cotton, wheat, corn, tobacco, and other crops; and a monthly summary of meteorological observations for eight years.

Bulletin 63, pp. 118.—Analyses of Commercial Fertilizers and Paris Green.—A discussion of the source and valuation of fertilizers, analyses of 1,817 samples of fertilizing materials, statistics of the fertilizer industry in the State, text of the State law regulating the sale and purity of Paris green, with analyses of a large number of samples.

Annual Report, 1900, pp. 22.—An account of the work of the Sugar Station, State Station, and the North Louisiana Station; the organization lists of the stations; and a financial statement for the fiscal year ended June 30, 1900.

GENERAL OUTLOOK.

The fertilizer requirements of the leading field crops of Louisiana and the best method of restoring fertility to worn-out soils are subjects that have occupied prominent places in the investigations of the Louisiana stations ever since their organization. The fertilizer experiments conducted simultaneously at the three stations during the past decade indicate that nitrogen is the element most needed by the soils of Louisiana for the production of every crop grown and that phosphoric acid is next in importance. The best method of restoring fertility has been found to be a system of rotation of crops, in which legumes figure prominently. Closely connected with these investigations is a systematic soil survey of the State, in which the officials of these stations have been engaged for a number of years. A geological survey of the State is also going forward under station auspices, special attention being given to sources of artesian water supply. The principal crops receiving attention are sugar cane, cotton, and tobacco, and with each of these a great deal of valuable work has been done. At the same time other crops are receiving attention and considerable effort is being directed to the introduction of the live-stock industry. The work is vigorously and intelligently prosecuted and is increasing in importance from year to year.

MAINE.

Maine Agricultural Experiment Station, *Orono.*

Department of University of Maine.

GOVERNING BOARD.

STATION STAFF.

George Emory Fellows, M. A., Ph. D., *President of the University.*

Chas. D. Woods, B. S., *Dir.*
J. M. Bartlett, M. S., *Chem.*
L. H. Merrill, B. S., *Chem.*
F. L. Russell, B. S., V. S., *Vet.*
W. M. Munson, M. S., *Hort.*
G. M. Gowell, M. S., *Stock Breeding and Poultry.*
Gilman A. Drew, B. S., *Zool.*
O. W. Knight, B. S., *Asst. Chem.*
E. R. Mansfield, *Asst. Chem.*
C. D. Holley, B. S., *Asst. Chem.*
H. W. Britcher, *Asst. Zool.*
M. B. Cummings, B. S., *Asst. Hort.*
Miss Annie M. Snow, *Sten.*

LINES OF WORK.

The work of the Maine Station during the past year followed substantially the same lines as in the previous year, including investigations on the food and nutrition of man and domestic animals, poultry experiments, breeding experiments with sheep, digestion experiments with sheep and steers, box and field experiments with fertilizers, horticultural investigations, work in veterinary science and practice, and botanical and entomological observations. A study of mollusks (scallops) was begun. The experiments in sheep breeding consist in the crossing of Dorsets to secure earliness of lambing combined with other qualities. The experiments in propagating and improving blueberries have been continued with promising results. The station has made studies of the nutritive value of concentrated foods, prepared flours and fruits, and, in cooperation with this Office, is continuing studies on the nutritive value and digestibility of cereals and bread with special attention to methods of determining digestibility. It is proposed that to this work be added studies of the dietaries of lumbermen, for which studies the opportunities are peculiarly favorable. The station is also cooperating with the Bureau of Plant Industry of this Department in the breeding of wheat and potatoes. Investigations on the effect of climate on the varieties of wheat and potatoes have been carried on as heretofore.

The station continues to cooperate with farmers in Aroostook and Kennebec counties in experiments in apple growing, which consist

of tests of varieties, mainly Russian, and tests of fertilizers, cultivation, and spraying, which have been in progress at this station for several years. To these have been added cooperative experiments in manuring and spraying potatoes in Aroostook County, very favorable terms having been arranged with farmers in that county.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	4,526.10
Farm products	2,714.36
Balance from previous year	103.62
Total	22,344.08

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–72.

Bulletin 66, pp. 16.—Fertilizer Inspection.—Tabulated analyses of 157 samples of fertilizers inspected by the station.

Bulletin 67, pp. 38.—Digestion Experiments with Sheep.—Note on Heats of Combustion.—Experiments with sheep to determine the digestibility of a number of feeding stuffs are reported in detail in tabular form. An investigation to compare determined and calculated heats of combustion is also reported.

Bulletin 68, pp. 22.—Experiments with Insecticides upon Potatoes.—This bulletin contains a detailed report of a series of experiments with several commercial insecticides in comparison with Paris green as a remedy for the potato beetle.

Bulletin 69, pp. 44.—Finances, Meteorology, Index.—A monthly summary of meteorological observations at Orono during 1900, a financial statement for the fiscal year ended June 30, 1900, an index to the annual reports of the station for 1897 to 1900, and brief notes by the director on the work of the station.

Bulletin 70, pp. 16.—Oats as Grain and Fodder.—A discussion of the importance and value of oats as grain and fodder, analyses of oats grown in different parts of the State, and coefficients of digestibility of oat products obtained in experiments at the station.

Bulletin 71, pp. 16.—Feeding Stuff Inspection.—Tabulated analyses of a large number of samples of feeding stuffs inspected in December, 1900, with a brief discussion of the results.

Bulletin 72, pp. 8.—Fertilizer Inspection.—Analyses of 136 samples of commercial fertilizers, with a summary of the chief provisions of the State fertilizer law.

GENERAL OUTLOOK.

The work of the Maine Station has been developed along both practical and scientific lines, and while much of it is of purely local value, much also, especially the feeding experiments and nutrition investigations, is of general interest. The cooperative work with farmers, investigations with blueberries, feeding, breeding, and fertilizer experiments, and the investigations with poultry, potatoes, and fruit are all of such vital interest locally that they are bringing the station into closer relations with the farmers of the State. The work with poultry is well planned and vigorously conducted, but the breeding problems have developed some unexpected complexities, and it seems necessary to study the causes of degeneration as well as of improvement of breeds.

Farmers' institutes were held by the State board of agriculture at about 90 different places during the year, and members of the station staff assisted at 50 of these. The inspection service performed by the station includes the testing of fertilizers, seeds, feeding stuffs, and creamery glassware, and is fully supported by State funds. The station has begun the publication of press bulletins which are quite generally used by the newspapers of the State, and the advisability of introducing correspondence courses, through the college, is being considered.

MARYLAND.

Maryland Agricultural Experiment Station, *College Park.*

GOVERNING BOARD.

STATION STAFF.

R. W. Silvester, *President of the College.*

Harry J. Patterson, B. S., *Dir.; Chem.*
James S. Robinson, *Hort.*
A. L. Quaintance, M. S., *Ent.*
Samuel S. Buckley, D. V. S., *Vet.*
W. T. L. Taliaferro, M. A., *Agr.*
J. B. S. Norton, M. S., *Bot. and Veg. Path.*
E. O. Garner, *Supt. Farm and Recorder of Expts.*
Ralph I. Smith, B. S., *Asst. Ent.*
Thos. M. Price, M. S., *Asst. Chem.*
E. P. Sandsten, M. S., *Assoc. Hort. and State Hort. Inspector.*
C. F. Doane, M. S., *Agr., Dairy Husb. and Bact.*
F. H. Blodgett, B. S., *Asst. Plant Path. and Bot.*
Jos. R. Owens, M. D., *Treas.*
B. H. Gibbs, *Clerk.*

LINES OF WORK.

The work of the Maryland Station during the past year has included chemical investigations, especially fertilizer tests, curing experiments with tobacco, feeding experiments, studies of milk preservatives, and of the digestibility of raw, pasteurized, and sterilized milk; dairy work, including bacteriological studies; field experiments with fertilizers and staple crops to test varieties, methods of culture, value of early and late planting, etc.; soil inoculation experiments; horticultural investigations, including greenhouse experiments, plant improvement by selection and breeding, and variety tests of fruits; studies in plant pathology, especially peach yellows, diseases of pears and apples, asparagus rust, cantaloupe blight, and diseases of carnations; entomological investigations. The station is cooperating with farmers in the State in a large number of experiments and with this Department as follows: With the Bureau of Plant Industry, in cereal investigations, a variety test of sweet potatoes, a study of the influence of origin of red clover seed on yield of crop, and experiments to determine the best crops for use in securing a continuous soiling series for dairy and farm stock; and with the Bureau of Chemistry, on the gluten content of wheat and on the influence of environment on the sugar content of muskmelons.

The divisions of plant pathology and entomology of this station are mostly occupied with inspection work connected with the State horticultural inspection law, but conduct careful investigations in order to determine the best methods of procedure in carrying out the provisions of the law. The veterinary division is attached to the station in the capacity of a department for consultation rather than for research work, but at present the veterinarian is also studying mammitis or garget, parturient paresis or milk fever, and acute hemorrhagic encephalitis of horses. This last disease has been positively identified within the last few months and is not, as commonly supposed, cerebro-spinal meningitis or staggers. In the chemical division the effect of preservatives on the digestibility of milk for calves has constituted quite a lengthy investigation and is still in progress. The station has recently inaugurated a system of apprenticeships in dairying and horticulture, furnishing young men board, room, and instruction along practical lines in consideration of their working several hours each day for the station. Station officers assist in farmers' institute work which is supported by a State appropriation of $4,000 in charge of the college.

The personnel of the station staff has suffered numerous changes during the year. The entomologist and plant pathologist and their assistants and the assistant soil physicist resigned to accept more desirable positions. Four of the vacancies have been filled, but that of

assistant soil physicist, owing to a decision of the station authorities to discontinue its regular soil work, will not be filled.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	4,440.08
Balance from previous year	98.72
Total	19,538.80

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 65–74 and the Annual Report for 1900.

Bulletin 65, pp. 37, figs. 19.—Insecticides, Fungicides, and Spraying Apparatus.—A popular account of the preparation and use of the more important insecticides and fungicides, descriptive notes on spraying apparatus, and a spray calendar.

Bulletin 66, pp. 44, maps 2.—The Occurrence and Composition of Lime in Maryland, together with the Results of Experiments in Testing its Use in Agriculture.—This bulletin includes a general discussion of the relation of lime to agriculture, the action of lime on soils, the time and methods of applying lime, methods of determining the need of lime, descriptions of different kinds of lime used in agriculture, the occurrence and composition of lime in Maryland, including analyses of 121 samples of limestone, 2 of oyster shells, 27 of burned lime, 5 of gas lime, and 90 of marl; and detailed accounts of several series of experiments with lime made at the station since 1889.

Bulletin 67, pp. 24, pls. 8.—The Culture and Handling of Tobacco.—Among the topics treated are the methods of selecting, grading, packing, and topping Maryland tobacco; varieties for Maryland and methods of improving them; uses of green manure for supplying humus and improving the yield and quality of tobacco, fertilizers for tobacco, root system of the tobacco plant, methods of tillage, and the relation of original and natural vegetation to the adaptability of soils for tobacco culture.

Bulletin 68, pp. 29.—Fertilizer Experiments with Different Sources of Phosphoric Acid.—An account of experiments begun in the spring of 1895 on tenth-acre plats to test the comparative availability of double superphosphate (soluble and reverted), dissolved boneblack, dissolved South Carolina rock, iron and alumina phosphate (reverted),

boneblack, raw bone meal, slag phosphate, ground South Carolina rock, and Florida soft phosphate.

Bulletin 69, pp. 30, pls. 7.—The Influence of Feed and Care on the Individuality of Cows.—An attempt to increase the productive capacity of the individual cows of a grade herd by systematic feeding and good care extending over a number of years is reported, the records being tabulated and the results discussed in regard to the effect of feeding and care upon the development of the cows.

Bulletin 70, pp. 52.—The Chemical Composition of Maryland Soils.—Analyses of 60 samples of soil representing typical soil formations of the State made in the laboratory of the Division of Soils of this Department; a discussion of the importance, object, and scope of soil work and the purpose and methods of chemical examination of soils; descriptions of the samples analyzed, and a discussion of their classification with reference to geological formations, typical crops, and chemical and mechanical composition.

Bulletin 71, pp. 13, pls. 2.—Notes on Spraying Peaches and Plums in 1900.—Notes on the occurrence of fruit rot (*Monilia fructigena*) upon peaches and plums and the results of experiments in spraying with Bordeaux mixture for the prevention of this disease.

Bulletin 72, pp. 25, pl. 1, figs. 4.—Peach Growing in Maryland.—A discussion of the historical development of the peach industry in Maryland, its present status, the culture of the orchard, and the marketing of the fruit.

Bulletin 73, pp. 14, figs. 2.—Suggestions About Combating the San José Scale.—An account of experiments conducted for the purpose of determining the effect of different percentages of kerosene on peach trees and on the San José scale, and a discussion of the value of crude petroleum, whale-oil soap, and fumigation with hydrocyanic-acid gas as remedies for the San José scale.

Bulletin 74, pp. 16, pls. 3, figs. 4.—Notes on Celery Blight.—Celery blight is described and experiments made during three years in shading and spraying plants with ammoniacal copper carbonate and Bordeaux mixture for the prevention of this disease are reported.

Annual Report, 1900, pp. 171, pls. 20, figs. 17, maps 2.—A brief review of station work, a meteorological summary for 1899, a financial statement for the fiscal year ended June 30, 1900, and reprints of Bulletins 63–67 of the station.

GENERAL OUTLOOK.

The Maryland Station has done and is doing much useful work to promote the diversification of agriculture in the State and to develop more intensive and modern methods of farming. The work of the station in surveying and mapping soils preceded and led up to the soil investigations in this Department. Farmers have been shown the

desirability of a discriminating use of fertilizers and the advantages of more careful cultivation of their crops. The establishment of dairy farming and dairying on a modern scientific basis has been helped by the feeding experiments and other work conducted by the station. The horticultural interests of the State have been promoted by pointing out improved methods of handling and marketing fruits and vegetables, by illustrating the opportunities offered by different markets and the varieties adapted to the same, and by the introduction of scientific methods for the repression of insect pests and plant diseases. All of this work has been done with funds appropriated by the National Government, with the exception of the small sums arising from the sale of farm products.

MASSACHUSETTS.

Hatch Experiment Station of the Massachusetts Agricultural College, *Amherst.*

Department of the Massachusetts Agricultural College.

GOVERNING BOARD.

James Draper (*Chair.*), *Worcester;* James W. Stockwell, *Boston;* William Wheeler, *Concord;* Elijah W. Wood, *West Newton;* William R. Sessions, *Springfield;* William H. Bowker, *Boston;* Henry H. Goodell, *Amherst.*

STATION STAFF.

H. H. Goodell, LL. D., *President of the College and Director.*

William P. Brooks, Ph. D., *Agr.*
George E. Stone, Ph. D., *Bot. and Myc.*
Charles A. Goessmann, Ph. D., LL. D., *Hon. Dir.; Chem.* (Fertilizers).
Joseph B. Lindsey, Ph. D., *Chem.* (Foods and Feeding).
Charles H. Fernald, Ph. D., *Ent.*
Samuel T. Maynard, B. S. *Hort.*
J. E. Ostrander, C. E., *Met.*
Henry M. Thomson, B. S., *Asst. Agr.*
Ralph E. Smith, B. S., *Asst. Bot. and Myc.*
Henri D. Haskins, B. S., *Asst. Chem.* (Fertilizers).
James E. Halligan, *Asst. Chem.* (Fertilizers).
Edward B. Holland, M. S., *First Chem.* (Foods and Feeding).
Philip H. Smith, B. S., *Asst. Chem.* (Foods and Feeding).
Henry T. Fernald, Ph. D., *Assoc. Ent.*
George A. Drew, B. S., *Asst. Hort.*
Henry L. Bodfish, *Observer.*

George F. Mills, *Treas.*

LINES OF WORK.

The work of the Massachusetts Hatch Station during the past year, as formerly, has included chemical investigations, analysis and inspection of fertilizers and concentrated commercial feeding stuffs, field experiments, horticultural work, study of diseases of plants and animals, digestion and feeding experiments, entomological investigations, study of dairy problems, and meteorological observations. In the division of foods and feeding, investigations are being continued on

the effect of foods, especially oils, on butter. Feeding experiments have been continued, in which nitrogenous crops, such as soy beans and cowpeas, are used instead of concentrated feeding stuffs. The field experiments include rotation experiments with different fertilizers. There are also experiments with different crops and fertilizers in cylinders and in pots. In the grass garden numerous varieties are grown, and some varieties of timothy sent from the West Virginia Station give promise of special usefulness. The agriculturist has recently published a three-volume manual of instruction on agriculture. The horticulturist is conducting numerous experiments with different kinds of cover crops, varieties of orchard and small fruits, vegetables, methods of culture, and fertilizers. The entomologist has conducted investigations on the elm-tree beetle, the San José scale, and other insects of the State. He has nearly completed an extensive catalogue of the Coccidæ of the world and is now considering the problem of fumigating large trees for eradicating San José scale. Several advanced students are making special investigations under the direction of the entomologist on such subjects as thrips, flies, and bumblebees. Asparagus rust and a disease of asters are among the important plant diseases receiving attention.

The inspection duties of the station are large and have recently been increased by the enactment of a law requiring dairy glassware to be tested by the station. The fertilizer inspection brings a small revenue to the station; the others merely pay expenses. The agriculturist finds increasing evidence that on Massachusetts soils the effect of fertilizers varies greatly with the crop under investigation. He is keeping a very careful record of the experiments conducted under his supervision and has introduced an improved system of recording notes. Feeding experiments with dairy cows show temporary effects from the use of oils, but after a time the amount of fat in the milk returns to the normal. The experiments in feeding nitrogenous crops instead of concentrated feeding stuffs indicate that it does not pay to grow such crops in Massachusetts for the protein in their seeds or hay. The veterinary building recently completed by the college is a substantial and conveniently arranged structure. The college library has one of the most important collections of agricultural literature in this country, and is outgrowing its present quarters.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	11,200.00
Fees	3,490.25
Farm products	2,091.08
Miscellaneous	2,050.50
Total	33,831.83

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 68–74, Meteorological Bulletins 138–148, and the Annual Report for 1900.

Bulletin 68, pp. 28.—Analyses of Commercial Fertilizers.—Tabulated analyses of 275 samples of fertilizing materials.

Bulletin 69, pp. 40, pls. 2, figs. 5, dgms. 7.—The Rotting of Greenhouse Lettuce.—Several diseases affecting greenhouse lettuce are described and a brief bibliography is given of the subject. An extended account is given of experiments conducted for the control, by the sterilization of the soil, of the "drop" caused by the fungus *Sclerotinia libertiana* and a disease due to a species of Rhizoctonia.

Bulletin 70, pp. 26.—Analyses of Fertilizers.—Tabulated analyses of 231 samples of fertilizing materials.

Bulletin 71, pp. 40.—Concentrated Feed Stuffs.—Condimental Stock and Poultry Foods.—Analyses of a large number of samples of feeding stuffs and of condimental stock and poultry foods and condition powders, with a discussion of the results.

Bulletin 72, pp. 16, pls. 4.—Summer Forage Crops.—A description of the different forage crops which have been grown at the station for soiling purposes, with a discussion of the relative advantages of pasturage and soiling, fertilizers for forage crops, and feeding forage crops for milk production, and tables showing the composition and digestibility of grasses, cereals, legumes, and various fodder mixtures.

Bulletin 73, pp. 15.—Orchard Experiments.—Notes on the methods followed at the station in the culture, fertilizing, and spraying of apples, peaches, pears, grapes, blackberries, raspberries, currants, and strawberries, with the results of variety tests, and a spray calendar.

Bulletin 74, pp. 16.—Analyses of Fertilizers and of Paris Green and Other Insecticides.—Analyses of 64 samples of fertilizing materials and 19 of Paris green and other insecticides, with directions for sampling fertilizers, notes on valuation, and State laws relating to commercial fertilizers.

Meteorological Bulletins 138–148, pp. 4 each.—Notes on the weather and monthly summaries of meteorological observations for the year ended April 30, 1901, with an annual summary for 1900 in Meteorological Bulletin 144.

Annual Report, 1900, pp. 132.—This contains a brief summary of station work during the year, a financial statement for the fiscal year ended June 30, 1900, and reports of the heads of departments reviewing in detail the different lines of station work during the year, and

giving in addition a summarized account of experiments relative to the effect of food and food constituents on the quality of milk and butter conducted at the station during a period of six years; analyses and coefficients of digestibility obtained in experiments with sheep of barnyard millet, with a discussion of its feeding value; a discussion of dried distillery grains, with analyses and results of digestion experiments with sheep; coefficients of digestibility of a number of feeding stuffs obtained in experiments with sheep; analyses of purslane and "Parson's six-dollar feed;" results of fertilizer inspection during the year; analyses of wood ashes, sludge, and phosphatic slag, with notes on their value for manurial purposes; brief notes on several plant diseases and on the Russian thistle; an account of investigations carried on for some time on the influence of various chemical solutions upon the germination of seed; brief notes on a number of insects troublesome during the year; results of comparisons of several nitrogenous fertilizers; an account of experiments with leguminous crops as nitrogen gatherers; results of comparisons of muriate and sulphate of potash and of different phosphates; an account of soil tests with grass and onions; results of experiments with corn in which a special fertilizer was compared with a fertilizer rich in potash, and manure alone was compared with manure and potash; notes on the relative value of soy beans and cowpeas for green manuring; results of experiments in manuring grass lands, and an account of feeding experiments with poultry.

GENERAL OUTLOOK.

In Massachusetts intensive agricultural methods prevail and problems of food supply for plants and animals are important. To these, and closely related problems, such as diseases and insects injurious to plants and animals, the station has given much attention. There are also important investigations in dairying, fruit growing, poultry raising, and market gardening. The inspection services performed by the station and the analysis of miscellaneous articles for farmers are important, but have grown to such proportions as to become burdensome. The utilization of the work of advanced students in connection with the entomological investigations of this station is a good example of the advantage of the combination of an experiment station and agricultural college in a single institution, provided it is well equipped for higher work in special lines.

MICHIGAN.

Experiment Station of Michigan Agricultural College, *Agricultural College.*[a]

Department of Michigan Agricultural College.

GOVERNING BOARD.

State Board of Agriculture: T. F. Marston (*Pres.*), *Bay City;* Franklin Wells, *Constantine;* Chas. J. Monroe, *South Haven;* Gov. Aaron T. Bliss, *Lansing;* Jonathan L. Snyder (*Pres. of College*), *Agricultural College;* E. P. Allen, *Ypsilanti;* H. F. Marsh, *Allegan;* L. W. Watkins, *Manchester.*

STATION STAFF.

Jonathan L. Snyder, M. A., Ph. D., *President of the College.*

Clinton D. Smith, M. S., *Dir.*
J. D. Towar, B. S., *Agr.*
Robert C. Kedzie, LL. D., *Chem.*
L. R. Taft, M. S., *Hort.*
M. L. Dean, *Asst. Hort.*
F. W. Robison, B. S., *Asst. Chem.*
George A. Waterman, D. V. M., *Consulting Vet.*
R. H. Pettit, B. S. A., *Ent.*
Chas. F. Wheeler, B. S., *Consulting Bot.*
Mrs. L. E. Landon, *Libr.*
C. E. Marshall, Ph. B., *Bact.*
T. A. Farrand, *In Charge of Substa.* (*South Haven*).
Leo. M. Geismar, *In Charge of Substa.* (*Chatham*).

Louzena D. Kellum, *Clerk and Sten.*

LINES OF WORK.

During the past year much of the work at the Michigan Station has been along lines taken up in previous years. These have included variety, cultural, fertilizer, and seasonal experiments with sugar beets; experiments with sand lucern, cowpeas, and other legumes for hay; rotation experiments begun in 1895; experiments at the station and on farms in different parts of the State with corn, oats, beets, and other crops grown on muck with different commercial fertilizers, stable manure, lime, ashes, etc.; variety tests of strawberries, fruits, and potatoes; spraying experiments with apples and other orchard fruits; fertilizer experiments with greenhouse crops; fertilizer inspection; seed testing; analysis of sugar beets and flours; study of new methods of judging wheats and flours; study of problems related to pure milk supply; entomological investigations, especially with scale insects and with wax to protect trees against peach borer; and forestry experiments.

Among new lines of work taken up may be mentioned experiments with tobacco, which is now becoming an important crop in the State; experiments in the utilization of sugar-beet pulp as a feeding stuff; feeding experiments with Western lambs *v.* Michigan lambs, studying incidentally liability to internal parasites; the growing of corn with cowpeas, soy beans, and other legumes for silage mixtures; experiments with varieties of wheats, hops, soy beans and miscellaneous

[a] Freight and express address, *Lansing.*

forage crops from seeds furnished by the Bureau of Plant Industry of this Department, and also with clover seed from different sources, and sand-binding grasses in cooperation with this Bureau; sugar-beet investigations and studies of the gluten content of wheat, in cooperation with the Bureau of Chemistry; soil investigations in cooperation with the Bureau of Soils; experiments, partly cooperative, in the rejuvenation of old orchards; preliminary investigation with concentrated feeding stuffs, and studies of new fungus diseases of fruits and beets.

A recent legislative enactment gives the State board of agriculture control of a fixed annual appropriation of $100,000 for the support of the college, substations, and farmers' institutes. From this amount, appropriations of $2,000 and $3,000, respectively, have been made for continuing the work at South Haven and Chatham during the current year. The offices in the new dairy building (Pl. II, fig. 1) for the director and agriculturist of the station give ample room for the storage and arrangement in accessible form of the station records and files Through the resignation of H. W. Mumford, assistant agriculturist of the station, experiments in stock feeding now devolve upon the director.

At the South Haven fruit substation the experiments consist mainly of variety tests of peaches, pears, plums, small fruits, and Russian watermelons, and experiments with nuts, such as chestnuts, pecans, etc. The plantation is in excellent condition. At the Chatham substation in the Northern Peninsula a residence for the superintendent and a barn (Pl. IV, fig. 1) have been completed and about 25 acres cleared and fenced. The remainder of the 160 acres is a dense forest, partly hardwood. The experiments thus far consist chiefly in growing varieties of wheat, oats, barley, alfalfa, sand lucern, peas, sorghum, vegetables, strawberries, apples, pears, etc. The work is conducted mainly for the purpose of demonstrating the agricultural possibilities of the region. It is being carefully done and is receiving cordial support from the people of the State.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	4,507.29
Fees	1,960.00
Farm products	1,516.07
Miscellaneous, including balance from previous year	733.54
Total	23,716.90

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

FIG. 1.—MICHIGAN COLLEGE AND STATION—DAIRY BUILDING.

FIG. 2.—IDAHO STATION—PIGGERY.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 179–188 and the Annual Report for 1900.

Bulletin 179, pp. 26, figs. 6.—Sugar-Beet Investigations.—Investigations here reported include fertilizer experiments with sugar beets on different soils at the station and in cooperation with farmers in different parts of the State, variety tests, and several culture experiments, including trials of planting at different dates.

Bulletin 180, pp. 30, pl. 1, figs. 14.—Some Insects of the Year 1899.—Economic and biological notes on 17 insects and suggestions regarding the preparation and use of the more common insecticides.

Bulletin 181, pp. 26, pl. 1, figs. 2.—Soil tests on Upland and Muck; Clover and Sand Lucern Notes; Wheat Experiments.—A report of cooperative experiments with fertilizers on corn, potatoes, field beans, and sugar beets at 13 different places in Michigan; an account of experiments on tenth and twentieth acre plants of swamp or muck land on the station farm to test the effect of different methods of fertilizing; notes on clover and sand lucern grown experimentally at the station; and the results of experiments with wheat, including a test of 12 varieties, culture experiments involving 5 different methods of preparing the seed bed, and a comparison of top-dressing and plowing under manure.

Bulletin 182, pp. 22.—A Popular Discussion of Pure Milk Supply.—Among the topics considered are the importance of pure milk for city trade and for the manufacture of butter and cheese, condition of dairies and stables of different types, germ content of milk drawn under different conditions, cooling of milk, use of preservatives, inspection and care of cows, and the construction of stables and milking rooms.

Bulletin 183, pp. 14, figs. 9.—Gassy Curd and Cheese.—A detailed account of a bacteriological study of a bacillus resembling *Bacillus coli communis*, isolated from gassy curd.

Bulletin 184, pp. 60, pls. 2, figs. 5.—Tuberculosis and its Management.—A discussion of the nature, prevalence, dissemination, geographical distribution, symptoms, etc., of tuberculosis, including the results of a number of investigations at the station; a detailed history of tuberculosis in the college herd since 1889; and suggestions regarding the management of tuberculosis.

Bulletin 185, pp. 16.—Fertilizer Analyses.—Tabulated analyses of 81 samples of fertilizers examined during 1900, with brief explanatory notes.

Bulletin 186, pp. 46, pls. 16, figs. 6.—First Report of the Upper Peninsula Experiment Station.—An account is given of the establishment and work of the Upper Peninsula Experiment Station, includ-

ing notes on culture and variety tests with different field crops, fruits, and vegetables; notes on the geology of the locality; lists of the plants, insects, spiders, and molluscs found at the substation; and a brief discussion of the characteristics of the soil of the Upper Peninsula.

Bulletin 187, pp. 48.—Report of South Haven Substation.—Results of tests of 61 varieties of raspberries, 29 blackberries, 28 currants, 20 gooseberries, 64 cherries, 113 peaches, 47 pears, 9 quinces, 47 plums, 81 grapes, 105 apples, 11 crab apples, and a number of varieties of European and Japanese chestnuts, filberts, and walnuts, with descriptive notes on many of the more important or newer varieties; and brief accounts of experiments in pruning back peach trees which had been injured by frost, experiments in thinning peaches, and spraying experiments.

Bulletin 188, pp. 14, fig. 1.—Experiments with Sugar Beets.—Tests of various kinds of soil for sugar beets, an experiment on the time of planting sugar beets, and distance, fertilizer, and variety tests conducted in 1900, on soils ranging from sand to loam.

Annual Report, 1900, pp. 478, pls. 4, figs. 62, map 1.—Reports of the director and heads of departments reviewing the work of the station during the year, a financial statement for the fiscal year ended June 30, 1900, meteorological observations, and reprints of Bulletins 175-185 of the station.

GENERAL OUTLOOK.

The Michigan Station is doing much to introduce new industries and new crops. As a result of preliminary investigations and experiments made by the station chemist, demonstrating the adaptability of Michigan soil to sugar-beet production, the State now contains 13 sugar factories, representing a total capitalization of $5,525,000. Six more companies are organized and will invest fully $2,000,000 in buildings for which contracts have been awarded. In this connection the station is now making somewhat extended investigations in the utilization of sugar factory by-products as feeding stuffs. Sand lucern has been introduced by the station, and its use as a hay crop and a green manure on light sandy soil has met with a success worthy of mention. The station has been instrumental, also, in the quite general introduction of cowpeas and soy beans on farms in the southern part of the State, and is investigating the use of these legumes with corn for silage mixtures. Tobacco is another recently introduced crop that is receiving attention at the station. In the rejuvenation of old orchards, fruit growers are working hand in hand with the station, and the results in some cases have been remarkable. The experiment in growing white pine at the college and on the plantation, about a mile away (Pl. III, figs. 1 and 2), is progressing well. The South Haven substation furnishes desired information to the fruit growers along the west coast

FIG. 1.—MICHIGAN STATION—WHITE PINE PLANTATION IN 1898.

FIG. 2.—MICHIGAN STATION—WHITE PINE PLANTATION IN 1901.

regarding varieties of fruit and methods of fighting fungus and insect enemies. The entomologist of the station has made a special study of Coccidæ, and will soon issue a monograph on scale insects. The botanist, in addition to testing seeds, has been called upon to study fungus diseases of fruits and beets in many parts of the State. The college and station are in prosperous condition, and are brought into intimate relation with the people of the State through farmers' institutes, in which the station officers participate, and through summer excursions to the college, which bring several thousand visitors each year.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of University of Minnesota.

GOVERNING BOARD.

Board of Regents: Greenleaf Clark (*Pres.*), *St. Paul;* Wm. M. Liggett, *St. Anthony Park;* Stephen Mahoney, *Minneapolis;* Elmer E. Adams, *Fergus Falls;* Thomas Wilson, *St. Paul;* A. E. Rice, *Willmar*; C. C. Strickler, *New Ulm;* Jas. T. Wyman, *Minneapolis;* T. L. Schurmeier, *St. Paul;* Gov. Samuel F. Van Sant, *St. Paul;* Cyrus Northrop, *Minneapolis;* John W. Olson, *Albert Lea;* J. E. Ware (*Treas.*), *Minneapolis.*

STATION STAFF.

Cyrus Northrop, LL. D., *President of the University.*

Wm. M. Liggett, *Dir.*
Willet M. Hays, M. Agr., *Agr.*
Samuel B. Green, B. S., *Hort.*
Harry Snyder, B. S., *Chem.*
T. L. Haecker, *Dairy Husb.*
M. H. Reynolds, M. D., V. M., *Vet.*
Andrew Boss, *Asst. in Agr.* (*Univ. Farm*).
F. L. Washburn, *Ent.*
T. A. Hoverstad, B. Agr., *Asst. in Agr.* (*Crookston*).
R. S. Mackintosh, *Asst. in Hort.* (*Univ. Farm*).
H. H. Chapman, B. S., B. Agr., *Asst. in Agr.* (*Grand Rapids*).
E. W. Major, *Asst. in Dairying.*
J. A. Hummel, B. Agr., *Asst. Chem.*

J. A. Vye, *Sec.*

LINES OF WORK.

The work of the Minnesota Station during the past year has been mainly along the same lines as heretofore, including field experiments with grain and forage crops, flax grown for fiber and seed, sugar beets, rotation of crops, etc.; horticultural and forestry investigations both at the main station and at the substations; entomological investigations, especially with reference to controlling an invasion of Rocky Mountain locusts; chemical studies of soils, foods, etc.; investigations in dairy farming and dairying; studies in veterinary science and practice; feeding experiments with cattle, sheep, and pigs, and breeding experiments with sheep and pigs. The station continues to conduct nutrition investigations in cooperation with this Office, and is cooperating with the Bureau of Forestry of this Department in tree planting

and with the Bureau of Plant Industry in efforts to improve the wheat industry of the Northwest.

The breeding and testing of varieties of cereals, grasses, millet, field peas, cowpeas, soy beans, etc., and the distribution of the promising varieties among the farmers for trial have developed into a well-organized system. The dairy division has continued extensive feeding experiments to determine the cost of producing milk and butter and is doing much to demonstrate to the farmers of the State methods of lowering the cost of producing butter. The Minnesota legislature at its last session made an appropriation of $90,000 for the college of agriculture. Of this sum $25,000 has been used in the construction of a veterinary laboratory, $25,000 will be used in erecting a chemical laboratory, $12,000 for an addition to the women's building, and $7,500 for a building to be devoted to instruction and experiments in curing meat. Other smaller sums will be used in bettering the dairy equipment and erecting barns at both the central station and the substations. The animal husbandman, Prof. Thomas Shaw, has recently published a book entitled Study of Breeds in America: Cattle, Sheep, and Swine. The veterinarian has retired from active management of the veterinary work for the State board of health and is now free to devote his whole time to teaching and experimenting. The station has suffered the loss of its entomologist and botanist, Dr. Otto Lugger, who died near the close of the fiscal year.

The substations at Crookston and Grand Rapids have been maintained, as heretofore, with State funds. The work of both substations is local in nature, that of the Crookston substation being confined to problems of the Red River Valley, and that of the Grand Rapids substation to forestry and general and truck farming.

INCOME.

The income of the station (including substations) during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	35,956.32
Farm products	7,246.14
Total	58,202.46

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 68 and 69, Class Bulletin 8, and the Annual Report for 1900.

Bulletin 68, pp. 176, pl. 1., figs. 37, dgms. 27.—Subexperiment Farms.—Notes are given on the purpose and management of the three substations in the State and results obtained at each of the farms are reported in detail. The work at the Coteau experiment farm included a study of the amount of soil moisture best suited to the growth of flax, various tillage experiments for the conservation of soil moisture, tests of a number of meadow and pasture crops, and observations on the value of shelter belts. The work at the Northwest experiment farm embraced variety tests with a number of grains, grasses, clovers, and forage crops, and experiments in seeding grasses and clovers with different nurse crops. The work at the Northeast experiment farm consisted of field tests with grains, forage crops, potatoes, vegetables, and orchard and small fruits.

Bulletin 69, pp. 259, pls. 24, figs. 196.—Bugs Injurious to Our Cultivated Plants.—A general account of the anatomy, life history, habits, and classifications of the order Hemiptera, including lice, Heteroptera, and Homoptera, and brief biological and economic notes on the more important species.

Class Bulletin 8, pp. 4.—Minnesota No. 163 Wheat.—A comparison of this wheat with other varieties, based on the results of tests made at the station.

Annual Report, 1900, pp. 772, pls. 9, figs. 296, dgms. 27.—This contains the organization list of the station; a financial statement for the fiscal year ended June 30, 1900; a general review by the director of the work of the different departments and of the experiment farms at Crookston, Grand Rapids, and Coteau; reprints of Bulletins 65-68 of the station, and meteorological observations.

GENERAL OUTLOOK.

The Minnesota Station is pursuing the well-defined policy of following up scientific investigations and research with practical application on the farms of the State. In the case of cereals and forage plants, the plan is to secure improved varieties by breeding and selection and then to distribute these varieties among the farmers. The distribution of new varieties of wheat and corn has already resulted in much good, and new varieties of flax, oats, barley, and others of wheat will soon be ready for distribution. Likewise the investigations of the dairy division on the production of milk and butter are made in the hope of giving the public methods of lessening the cost of producing these commodities. Plans and appropriations have been made for improving the equipment of the dairy building and for strengthening the course in the dairy school of the university, which has done much already to improve dairy methods in the State and to give a better reputation to Minnesota butter. Closely related to dairying and the live-stock interests generally are veterinary investigations and those in curing

meats, which are to be carried on under better facilities than formerly. Horticultural experiments and forestry investigations are going forward both at the main station and at the substations in remote parts of the State. The university with which the station is connected administers the funds appropriated by the State for farmers' institutes, the superintendent of which also cooperates with the station in conducting experiments at Coteau farm. The school of agriculture of the university continues to be well patronized and is doing good work.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.* [a]

Department of Mississippi Agricultural and Mechanical College.

GOVERNING BOARD.

Board of Trustees: Gov. A. H. Longino (*Pres. ex officio*), *Jackson;* R. C. King (*Sec.*), *Agricultural College;* G. W. Carlisle (*Treas.*), *Jackson;* W. B. Montgomery, *Starkville;* H. M. Street, *Meridian;* T. C. Dockery, *Love Station;* S. D. Lee, *Columbus;* R. C. Lee, *Madison Station;* W. H. Morgan, *Sheppardtown;* J. J. Coman, *Jackson;* Henry L. Whitfield, *Jackson;* J. F. McCool, *Kosciusko;* J. B. Bailey, *Conehatta;* J. C. Hardy (*Pres. of College*), *Agricultural College;* W. L. Hutchinson, *Agricultural College.*

STATION STAFF.

J. C. Hardy, *President of the College.*

W. L. Hutchinson, M. S., *Dir.; Chem.*
E. R. Lloyd, M. S., *Asst. Dir.; Agr.*
G. W. Herrick, B. S., *Bot. and Ent.*
A. B. McKay, B. S., *Hort.*
J. C. Robert, D. V. M., *Vet.*
W. R. Perkins, M. S., *Assoc. Chem.*
J. S. Moore, M. S., *Dairy Husb.*
C. T. Ames, B. S., *Asst. Hort.*
R. C. King, B. S., *Treas.*
Miss Maud Butler, *Sten.*

LINES OF WORK.

The work of the Mississippi Station during the past year has been mostly a continuation of investigations begun in former years, and has included soil studies; investigations in beef and mutton production; dairying; diseases of live stock; variety tests of orchard and small fruits, cotton, corn, and wheat; and investigations of injurious insects and artesian waters. The soil studies have comprised investigations on the chemical and physical composition of the various types and formations of soils in the State; investigations of the plant-food content in, and productiveness of, the several typical soils; experiments in the use of commercial fertilizers, manures, and restorative crops for the improvement of soils; experiments in the use of graded embankments, level embankments, and terraces for the prevention of soil washing. In this connection experiments and demonstrations in constructing dirt roads have been made. The experiments in beef and mutton production have included, in part, breeding experiments with native and grade cattle and sheep, feeding experiments with dif-

[a] Freight and telegraph address, *Starkville.*

ferent combinations of Southern forage plants and feeding stuffs, and investigations and demonstrations of the advantages of stock raising for maintaining soil fertility. Experiments in immunizing Northern cattle to Texas fever have been continued. The experimental peach orchard is now in fine condition and is being used for variety, cultural, and pruning experiments. Special attention is being given to tests of varieties of strawberries. Among other experiments may be mentioned rotations with burr, white, and alsike clover, Melilotus, Lespedeza, water grass (*Paspalum dilatatum*), and a number of other grasses for pasture; and experiments in handling milk under Southern conditions. The inspection of commercial fertilizers is under the supervision of the professor of chemistry in the agricultural college, who is also State chemist. The chemist of the station is studying methods of analysis for nitrogen in cooperation with the Bureau of Chemistry of this Department.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	632.74
Miscellaneous, including balances from previous year	924.24
Total	16,556.98

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 62–67 and the Annual Report for 1900.

Bulletin 62, pp. 8.—Varieties of Cotton.—Detailed data regarding the yield, value, and commercial classification of 24 varieties of cotton tested in 1899, with a summary of the results of variety tests with cotton for 10 years.

Bulletin 63, pp. 11, fig. 1.—Inoculation of Soils.—An account of soil inoculation experiments with hairy vetch, with some general remarks on relation of air to plants, methods of inoculating the soil, etc.

Bulletin 64, pp. 32.—Inspection and Analyses of Fertilizers.—Tabulated analyses and valuations of 211 samples of fertilizers, with explanatory notes.

Bulletin 65, pp. 19, figs. 3, map 1.—Soils of Mississippi.—Chemical and mechanical analyses of 375 samples of representative soils from different parts of the State, with a map showing the location and extent of the different soil areas and a discussion of the analytical results.

Bulletin 66, pp. 23, pls. 2, figs. 4, map 1.—Soils of Mississippi.—Analyses of 76 samples of prairie soils and 46 samples of sandy and

sandy loam soils showing the content of phosphoric acid, potash, nitrogen, and lime; an explanation of the construction and use of embankments and terraces to prevent washing of soils; and a discussion of the reclamation of washed lands, the value and use of stable manure, the restoration of crops, and the use of commercial fertilizers.

Bulletin 67, pp. 16, pl. 1, figs. 5.—Good Dirt Roads for Mississippi.—The road laws of Mississippi are briefly summarized and the system of road maintenance of the State is discussed. Methods of building and maintaining dirt roads are briefly explained.

Annual Report, 1900, pp. 126, figs. 3.—This includes the organization list of the station; a financial statement for the fiscal year ended June 30, 1900; a general report on station work during the year by the director, and more detailed reports by the heads of departments containing results of variety tests with cotton and wheat, and culture experiments with sorghum, cowpeas, and corn, an account of feeding experiments with steers to determine the comparative value of different feeding stuffs, a record of the dairy herd for one year, results of a test of feeding grain to dairy cows on pasture, notes on inoculation experiments for the prevention of Texas fever, and on the occurrence of black-leg, anthrax, glanders, and tuberculosis in the State, and notes on several insect pests and plant diseases. Reprints of Bulletins 60 and 62–64 of the station are appended.

GENERAL OUTLOOK.

The station is wisely continuing active operations for the improvement of soils throughout the State, and to this end is demonstrating the value of animal production and the use of manures, fertilizers, restorative crops, and rotations to increase productiveness, and the efficacy of embankments and terraces to prevent soil washing. Other related problems, such as forage production, dairying, studies of Texas fever, and of means for combating insect pests are given such prominence as their importance demands, and at the same time the station is making helpful investigations in the production of fruit, corn, wheat, and cotton. During the year 8 members of the college and station staffs assisted at 23 farmers' institutes. The institute work is growing in importance, and should receive more liberal support from the State.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of the State of Missouri.

GOVERNING BOARD.

Board of Curators—Executive Committee: R. B. Oliver (*Pres.*), *Cape Girardeau;* Campbell Wells, *Platte City;* G. F. Gmelich, *Boonville.*

Advisory Council: The Missouri State Board of Agriculture.

STATION STAFF.

R. H. Jesse, LL. D., *President of the University.*

Henry J. Waters, B. S. A., *Dir.*
Paul Schweitzer, Ph. D., *Chem.*
J. C. Whitten,[a] B. S., *Hort.*
J. M. Stedman, B. S., *Ent.*
J. W. Connaway, M. D. C., *Vet.*
C. H. Eckles, B. Agr., M. S., *Dairying.*
W. L. Howard, B. S., *Asst in Hort.*
C. Thom, Ph. D., *Asst. Bot.*
John Schnabel, *Gard.*
J. G. Babb, M. A., *Sec.*
R. B. Price, *Treas.*
Miss Estelle Hickok, *Clerk and Sten.*

LINES OF WORK.

The work of the Missouri Station during the past year has been continued along practically the same lines as formerly, and has included field experiments with cereals, forage crops, fertilizers, rotation of crops, systems of drainage, methods of renovating worn-out soils, etc.; field, greenhouse, and laboratory experiments in horticulture; a study of the influence of crossing different types of sheep with native ewes upon the weight and quality of the carcass and wool of the offspring; feeding experiments with beef cattle; investigations of animal diseases, including experiments in immunizing Northern pure-bred cattle against Texas fever by blood inoculation and tick infestation, and a study of the life histories of and remedies for animal parasites, such as the tapeworm of sheep and the lung and stomach worms of sheep and cattle; chemical study of food adulterants, the artifical method of determining the digestibility of feeding stuffs as compared with the use of animals for this purpose, and the composition, fuel value, and feeding value of the different animal and vegetable fats of commerce; mechanical tests of farm wagons and spray nozzles; entomological studies, especially of insects affecting fruit; experiments in selection, amelioration, and cultivation of edible nuts; experiments with fruits, including variety tests of apples, plums, grapes, peaches, pears, and small fruits, and tests of commercial fertilizers in nurseries and bearing orchards in different parts of the State, and breeding experiments with the peach, plum, persimmon, strawberry, grape, and tomato. The inspection of commercial fertilizers has been continued under State laws. The station has assisted the State board of agriculture in regulating the sale of artificial butter and in the enforcing of State laws against infectious diseases of live stock. It has also cooperated with the State Horticultural Society in the inspection of nursery stock. Besides these lines of work, many of which have been in progress for a number of years, the station has recently undertaken irrigation investigations in cooperation with this Office, an investigation of the gluten content of wheat in cooperation with the Bureau of Chemistry of this Department, and studies on the influence of origin of red-clover seed on yield of crop

[a] On leave.

and the formation and management of meadows and pastures in cooperation with the Bureau of Plant Industry of this Department.

The State legislature at its last session made liberal appropriations to the university, over $100,000 being provided for the agricultural department. Of this, $40,000 is given for a dairy and live-stock building and equipment, and an equal amount for a horticultural, entomological, and botanical building and equipment, both of which will be of direct benefit to the station in furnishing quarters and equipment for its different departments. The appropriation also carried $3,500 for maintenance of the station, to be used as a printing fund to carry out the provisions of the law authorizing the printing of station publications by the State printer, and $5,000 for work in dairying, including the establishment of a chair of dairy husbandry in the college of agriculture.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	2,676.99
Fees	1,373.30
Balance from previous year	2,711.25
Miscellaneous	20.15
Total	21,781.69

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 49 and 50.

Bulletin 49, pp. 21, pls. 2, figs. 4.—The Apple Orchard.—An account of experimental work conducted at the station during 5 years in regard to the preparation of the soil for apple orchards and the relation of cultivation and care to the development and growth of apple trees, together with a discussion of different crops for growing in orchards and the value of different cultural methods.

Bulletin 50, pp. 31, pls. 7, figs. 3.—A Test of Spray Nozzles.—A comparative study was made of 30 kinds of nozzles from different manufacturers, with reference to the following points: Height of spray or distance which the spray could be thrown perpendicularly with various pressures; width, shape, and distribution of the spray at the point where it was considered most efficient; size of the drops; amount of liquid discharged by each nozzle in a given time; liability of the nozzle to clog; liability to dribble; durability, and method of attachment.

GENERAL OUTLOOK.

The Missouri Station has continued to direct its work along two important lines—fruit growing and animal production. A bulletin on the apple orchard has been published which embodies the results of five years of experimental work in the cultivation and care of the orchard. The importance of this work and of the fruit interests of the State has been recognized by the State legislature in an appropriation of $26,000 for the establishment and maintenance in southern Missouri of a fruit experiment station which will relieve, to a certain extent, the college station of its investigations in that section. In animal production the station has undertaken to breed up a herd of cattle immune to Texas fever. A tick-infested pasture is maintained for immunizing in the natural way as compared with blood inoculation. The veterinarian, in cooperation with the entomologist, is giving special attention to studies of intestinal parasites of cattle and sheep. Considerable attention is being given also to experiments with corn stover variously treated and in combination with other forage plants for wintering and fattening cattle, and to experiments in the use of rotations and the establishment and maintenance of pastures.

Station officers take part in farmers' institutes and other forms of college extension work. A feature of the latter has been the effort to introduce instruction in elementary agriculture into the rural schools. This work has met with such popular approval that chairs of agriculture for the training of public-school teachers have been established in the three State normal schools.

Missouri State Fruit Experiment Station, *Mountain Grove.*

GOVERNING BOARD.

STATION STAFF.

J. T. Stinson, B. S., *Dir.*
Frank Horsfall, B. S., *Asst.*
A. M. Swartwout, *Foreman.*

LINES OF WORK.

The Missouri State Fruit Experiment Station was established by the Fortieth General Assembly of the State (1899–1900), and work was begun February 1, 1900. The law establishing the station stipulated that it be located in the Ozark region of southern Missouri, and further provided that the station should test different fruits and have charge of the orchard inspection work of the State. A tract of land containing 190 acres, 60 of which are improved, has been secured, buildings have been erected, and testing grounds and orchards are being planted as rapidly as possible. The buildings include the

experiment station building (Pl. IV, fig. 2), residences for the director and the foreman, and a barn. The station building is of red pressed brick and contains the experiment station offices, two large laboratory rooms, and a museum room.

The work already undertaken includes variety tests, improvement of varieties by selection, originating new varieties by cross pollenization, and the study of diseases and insects injurious to fruits. A careful study is being made of the orchard conditions of the Ozark region, and cooperative orchard work in spraying and cultivation has been started. In executing the inspection laws of the State the station is required to treat or destroy orchards infected with scale insects or dangerous diseases.

INCOME.

The station is supported entirely by State appropriation, the amount for the years 1901 and 1902 being $26,525.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 1 and the Annual Report for 1900.

Bulletin 1, pp. 21.—Preliminary Report on the Bitter Rot of Apples.—This bulletin gives the results of experiments carried on at the station to prevent bitter rot of apples, and contains information concerning the disease collected from apple growers in different parts of the country.

First Annual Report, 1900, pp. 20.—This report consists of two parts—a communication from the board of trustees to the Forty-first General Assembly of Missouri, and a report from the director to the board of trustees. The trustees report the selection of a site for the experiment station, the purchase of land, election of manager and inspector, erection of buildings, and progress of the experiment station; recommend changes in the law governing the station, and submit estimates for appropriations. The director reviews the work of the station and submits a statement of receipts and expenditures for the year ended December 31, 1900.

GENERAL OUTLOOK.

The production of fruit, especially apples, is one of the two important agricultural industries of the State, and southwestern Missouri is especially well adapted to this industry. The experiment station at Columbia has conducted investigations on the subject of fruit growing and has been aided in the work by the State Board of Agriculture and the State Horticultural Society. The establishment of the State Fruit Experiment Station at Mountain Grove shows the popularity of investigations of this nature and will supplement the work of the Columbia station in the region in which the new station is located.

FIG. 1.—MICHIGAN STATION—BUILDINGS AT CHATHAM SUBSTATION.

FIG. 2.—MISSOURI STATE FRUIT EXPERIMENT STATION BUILDING.

MONTANA.

Montana Agricultural Experiment Station, *Bozeman.*

Department of Montana Agricultural College.

GOVERNING BOARD.

Executive Board: Walter S. Hartman (*Pres.*), *Bozeman;* Peter Koch (*Sec. and Treas.*), *Bozeman;* John M. Robinson, *Bozeman;* Joseph Kountz, *Bozeman;* E. B. Lamme, *Bozeman.*

STATION STAFF.

Rev. James Reid, B. A., *President of the College.*

S. Fortier, M. E., *Dir.; Irrig. Engin.*
F. W. Traphagen, Ph. D., *Chem.*
Robert S. Shaw, B. S. A., *Agr.*
Henry C. Gardner, *Asst. Agr.*
Edmund Burk, *Asst. Chem.*
J. W. Blankinship, Ph. D., *Bot.*
Robert A. Cooley, B. S., *Zool.*
E. J. S. Moore, *Asst. Ent.*

M. A. Lamme, *Sten. and Clerk.*

LINES OF WORK.

The work of the Montana Station during the past year has been continued along the same lines as formerly, and has included irrigation investigations; the introduction and testing of improved varieties of cereals, root crops, and forage plants; rotation experiments; feeding experiments with steers and lambs in carload lots for shipment; chemical investigation of sugar beets, alkali soils, alkali limit of plant growth, irrigation and alkali waters, soils, etc.; entomological work; botanical study of weeds, poisonous plants, ornamentals, forage plants, and parasitic fungi; poultry work; and horticultural work, especially the introduction of varieties suited to the climate of the State. The irrigation investigations included experiments with different crops, experiments in pots to determine the effect on plant growth of tailings water and tailings sediment from mines, and work in cooperation with this Office in the Bitterroot Valley and on the Yellowstone. The station is also cooperating with farmers in testing new varieties and in sugar-beet work, with the Bureau of Plant Industry of this Department in the study of plants poisonous to stock, and with the Bureau of Forestry in tree planting.

The station has been very successful in growing clover and is exercising a most noticeable influence on the farmers in the direction of doing away with summer fallowing and growing clover instead. The station supervises the hydrographic work of the U. S. Geological Survey in Montana and makes all measurements of streams in the State. It is now the only irrigation bureau in the State and the irrigators depend upon it for information. The station is planning to buy a herd of dairy cows and has been given $2,500 by the State legislature for the erection of a dairy building, the equipment for which is partly on hand. The legislature has also given $2,000 a year for the support of farmers' institutes, which will be in charge of a board, of which the director of the station is secretary.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	200.00
Farm products	3,549.04
Total	18,749.04

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 22–29.

Bulletin 22, pp. 42.—The Resistance of Strawberries to Frost, and Twelve Other Subjects.—A discussion, with original observations and results of experiments, of the following subjects: The resistance of strawberries to frost, potato scab, treatment of seed oats for smut, losses caused by the grain aphis, roup of chickens, the internal chicken mite, lupines as plants poisonous to stock, cattle poisoning by the tall larkspur, poisoning of stock by the water hemlock, ergotism in horses, the poisoning of cattle by smutty oat hay, list of plants of known or suspected poisonous properties which occur within the State, and some native forage plants of the State.

Bulletin 23, pp. 53, figs. 38.—Injurious Fruit Insects; Insecticides; Insecticide Apparatus.—Brief popular notes on some 15 insects injurious to fruits, directions for the preparation and use of the common insecticides, and descriptions of spraying apparatus.

Bulletin 24, pp. 38.—Annual Report, 1899.—This includes the organization list of the station; a financial statement for the fiscal year ended June 30, 1899; a report of the director on the work and publications of the station during the year; and departmental reports, that of the horticulturist giving notes on various orchard fruits, an account of a test of the Stringfellow method of root pruning, and results of a test of 61 varieties of strawberries, that of the assistant agriculturist giving data for tests of 66 varieties of wheat, 44 of oats, and 21 of barley.

Bulletin 25, pp. 7.—Paris Green and London Purple in Montana.—Analyses of 6 samples of Paris green and 2 samples of London purple bought of dealers in the State.

Bulletin 26, pp. 28, pls. 5, figs. 2, dgms. 2.—Poultry Raising.—The station poultry equipment is described and general statements are made concerning breeds, incubation, buildings, brooders, and similar topics. Tests are reported of the relative merits of a lime-and-salt solution and a solution of water glass for preserving eggs and of the

comparative value of a rather varied ration, a meat ration, a vegetable ration, and a ration of grain alone. The percentage of fertility and analyses of the eggs obtained in the feeding experiments are reported.

Bulletin 27, pp. 32.—Live Stock Feeding Tests.—Details and results of feeding experiments with (1) 16 steers to learn whether local farm products can profitably be used in finishing range steers for market, and to what extent it is profitable to use grain with clover in a fattening ration, and to compare the relative values of typical beef animals as meat producers with those conforming to the dairy type; (2) 60 lambs to test the value of grain supplementing clover in feeding lambs for market; and (3) 21 pigs to compare feeding grain alone, grain with sugar beets, and grain with alfalfa.

Bulletin 28, pp. 24.—Annual Report, 1900.—This contains the organization list of the station; a financial statement for the fiscal year ended June 30, 1900; a list of exchanges; subject list of station bulletins, and reports of the director and heads of departments, that of the horticulturist giving lists of the hardy, semihardy, and poor or useless ornamental shrubs and fruits grown at the station, and brief notes on several experiments in progress, that of the agriculturist giving the yields of field crops grown under the Campbell system and under general methods of culture and in rotation experiments.

Bulletin 29, pp. 44, pls. 10.—The Quantity of Water Used in Irrigation and the Seepage Loss from Canals.—This is an account of investigations made during 1900 under the supervision of the expert in charge of irrigation investigations of this Office. Records are given of observations on the duty of water in the Gallatin and Bitter Root Valleys, in Yellowstone County, and in Middle Creek Canal. A study of the losses due to seepage and evaporation on five canals, and their relation to the duty of water, is reported, and conditions affecting seepage are discussed. Results for one year of a series of experiments undertaken to determine the proper amount of water to apply to growing crops, and the proper time to irrigate, are also given.

GENERAL OUTLOOK.

The Montana Station has a considerable amount of valuable work in hand, and is keeping itself before the farmers by means of articles prepared for papers, press notices, and successfully conducted farmers' institutes. The institutes were much better attended last year than formerly, and more interest has been aroused by them. The correspondence of the station has increased greatly, and there are many evidences of the good will of stockmen and farmers toward it. As the work of this station grows in importance, it is evident that increased financial support should be given to the institution with which it is connected, in order that the station officers may be relieved from college duties to such an extent as to permit them to devote themselves more fully to the station business.

NEBRASKA.

Agricultural Experiment Station of Nebraska, *Lincoln.*

Department of the University of Nebraska.

GOVERNING BOARD.

Regents of the University: E. von Forell (*Pres.*), *Kearney;* Geo. F. Kenower, *Wisner;* Edson C. Rich, *Omaha;* John L. Teeters, *Lincoln;* Elisha C. Calkins, *Kearney;* Carl J. Ernest, *Lincoln.*

STATION STAFF.

E. Benjamin Andrews, LL. D., *Chancellor of the University.*

E. A. Burnett, B. S., *Dir.; Animal Husb.*
T. L. Lyon, B. S. A., *Assoc. Dir.; Agr.*
H. H. Nicholson, M. A., *Chem.*
C. E. Bessey, Ph. D., *Bot.*
Lawrence Bruner, B. S., *Ent.*
E. H. Barbour, Ph. D., *Geol.*
A. T. Peters, D. V. M., *Animal Path.*
G. D. Swezey, M. A., *Met.*
O. V. P. Stout, C. E., *Irrig. Engin.*
A. T. Wiancko, B. S. A., *Asst. Agr.*
R. A. Emerson, B. S., *Hort.*
A. L. Haecker, B. S., *Dairy Husb.*
Henry B. Slade, B. A., *Asst. Chem.*
J. H. Gain, M. D. C., *Asst. in Animal Path.*
H. R. Smith, B. S., *Asst. Animal Husb.*
S. W. Perin, *Foreman of Farm.*
J. S. Dales, M. Ph., *Financial Sec.*
W. W. Marshall, *Executive Clerk.*

LINES OF WORK.

The work of the Nebraska Station during the past year has included investigations in chemistry, botany, soils, horticulture, forestry, stock feeding, field crops, animal diseases, entomology, and irrigation. The horticulturist is making a comparative test of irrigation, no irrigation, and mulching with fruits and vegetables; developing fruits, vegetables, and ornamentals that will withstand dry summers and cold winters; and conducting orchard experiments with different methods of culture with and without cover crops. In animal husbandry special attention is being given to the feeding of cattle, sheep, and pigs, and to testing the different forage plants for soiling and pasture in connection with dairy cows. The pathological investigations include work with the cornstalk disease, sorghum poisoning, hog cholera, and blackleg. The work in agronomy includes studies of methods for conserving soil moisture; the production of forage crops adapted to regions of limited rainfall; the improvement of winter wheat, corn, oats, and sugar beets; and the maintenance of soil fertility by the use of manures, leguminous crops, and rotations. The chemist has devised a rapid method for the determination of sugar in beets, and a mechanical device for collecting precipitates.

The station is cooperating with this Office in irrigation investigations; with the Bureau of Plant Industry of this Department in the cultivation and improvement of native grasses and in an investigation of the influence of environment on plants; with the Division of Entomology in the study of means for destroying locusts and grasshoppers, including the use of the grasshopper fungus disease; and with the

Bureau of Forestry in tree planting. The station also cooperates with a large number of farmers in making tests of various grains, remedies for injurious insects and diseases of fruits, and methods of cultivating and otherwise handling orchards. For its investigation of the cornstalk disease and sorghum poisoning of cattle the station has received a special State appropriation of $2,500. The veterinarian believes that the cause of cornstalk disease is the presence of poisonous weeds (black nightshade and water hemlock) in the fodder. In the investigation of sorghum poisoning chemical and bacteriological studies are now being made in the hope of discovering the cause of deaths. The veterinarian is investigating methods of rendering hogs immune from hog cholera. Recent experiments lead him to believe that unborn pigs can be immunized by inoculating the mother about two weeks before farrowing time with a virulent culture, provided the sow be already immune. Since January 1, 1901, the station has distributed over 60,000 doses of blackleg vaccine to people in the State. The appointment of a State veterinarian has relieved the station veterinarian from considerable routine business.

At the close of the fiscal year the chancellor of the university retired from the directorship of the station, and Prof. E. A. Burnett, animal husbandman, was made director. At the same time both the animal husbandman and the agriculturist were given assistants. The animal husbandman had charge of farmers' institutes in the State last year, and other members of the station staff assisted in the work.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,205.77
Balance from previous year	689.01
Total	16,894.78

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 65–70.

Bulletin 65, pp. 26, figs. 8, map 1.—Blackleg: Its Nature, Cause, and Prevention.—A popular discussion of the etiology, symptoms, treatment, etc., of blackleg, with detailed directions for making preventive vaccinations against this disease.

Bulletin 66, pp. 16.—Sheep Feeding Experiments in Nebraska.—An account of feeding experiments with 100 sheep to determine the value

of different combinations of corn and other grains with alfalfa hay and prairie hay.

Bulletin 67, pp. 8, pls. 2.—Experiments in the Culture of the Sugar Beet.—A summary of the results of culture, fertilizer, and variety tests with sugar beets during the season.

Bulletin 68, pp. 8.—Feeding Skim Milk to Calves.—A detailed account of an experiment with 6 calves conducted to ascertain the profit of raising beef calves on separator milk.

Bulletin 69, pp. 13, figs. 13.—Some Forage Plants for Summer Feed.—A report on experiments with a number of forage plants for the purpose of determining their relative value for pasturage and for soiling, and comparing the value of certain of these crops for milk and butter production under the two systems of feeding.

Bulletin 70, pp. 12, figs. 13.—Locusts or Grasshoppers.—An analytical table for the purpose of assisting in the identification of 10 common species of grasshoppers in the State, notes on the life history of grasshoppers, and a discussion of fungus diseases and artificial means for destroying them.

GENERAL OUTLOOK.

The experimental work of the Nebraska Station is each year assuming a more definite and fixed character. The tendency is for the different departments to unite their efforts on certain problems and study them from different points of view. Thus the irrigation engineer, the horticulturist, and the agriculturist are studying different phases of the problem of irrigation; likewise the horticulturist and the entomologist are cooperating in orchard work, and the chemist and the botanist are assisting several other members of the staff. A large part of the work has been directed toward the investigation of problems of plant production in regions where the winters are cold and the summers subject to drought. This work is of special importance in view of the extensive production of live stock in the State, and so, too, are the feeding experiments, dairy investigations, and the study of diseases of animals. It is very encouraging to have the State make a special appropriation for investigations by the station. The university is also contributing liberally to the support of the station.

During the year considerable attention has been given to systematizing the business affairs of the station and revising the mailing list, which has quadrupled during the last two years. This evidence of increasing interest in the work of the station, together with the differentiation of its organization and the liberal attitude of the university toward it, makes the outlook of the station very promising for increased usefulness to the farmers of the State.

NEVADA.

Nevada Agricultural Experiment Station, *Reno.*

Department of Nevada State University.

GOVERNING BOARD.

J. N. Evans (*Pres.*), *Reno;* W. E. F. Deal, *Virginia City;* W. W. Booher, *Elko.*

STATION STAFF.

Joseph E. Stubbs, M. A., D. D., *President of the College and Director.*
Ransom H. McDowell, B. S., *Agr. and Animal Husb.*
Nathaniel E. Wilson, M. S., *Chem.*
Peter Fransden, B. A., *Zool. and Bact.*
P. Beveridge Kennedy, *Bot. and Hort.*
Elizabeth Spayd Stubbs, *Sten.*
Samuel B. Doten, *Ent.*
Theodore Clark, *Foreman Farm.*
H. H. Dexter, B. A., *Libr.*

LINES OF WORK.

The lines of work pursued at the Nevada Station during the past year included field experiments, with and without irrigation, with cereals, alfalfa, and forage plants gathered from the valleys and bench lands; botanical study of forage problems on sheep ranges of the Sierra region and of grasses in the vicinity of Reno; entomological study of an onion maggot, cutworms injurious to alfalfa, and the flat-headed apple borer. In cooperation with the Bureau of Plant Industry of this Department the department of botany and horticulture has undertaken the improvement of native grasses; the development of a drought-resistant variety of alfalfa; and tests of the value of salt-bushes in Nevada, of the best grasses for meadows, and of drought-resistant grasses for ranges. Irrigation investigations have been continued in cooperation with this Office. An instrument for carefully measuring the water used has been installed, and the agriculturist is to be given an assistant for irrigation work, whose salary is to be paid out of funds appropriated by the State for irrigation investigations.

The station was badly crippled by the fire of August, 1900, which destroyed the station building, together with the valuable botanical and entomological collections and part of the books and laboratory equipment used by the station officers. The latter now occupy the former Mines Building, which furnishes good quarters for all of the departments except that of chemistry. The State, however, has given $12,000 for a new chemical building, which will be completed during the coming winter, and will furnish adequate laboratory facilities for the chemical work of the station. During the year six members of the staff have taken part in farmers' institutes. Nature-study work has been undertaken by the university with promise of success.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	430.65
Miscellaneous, including balance from previous year	572.88
Total	16,003.53

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 46–50.

Bulletin 46, pp. 15, figs. 24.—Flowers and Fruits of Common Trees and Shrubs.—The general structures of flowers and fruits are described and the flowers and fruits of a number of the more common trees and shrubs are figured and discussed.

Bulletin 47, pp. 90, figs. 92.—Clover Seeds and Their Impurities.—Results of extended studies of clover seed and its impurities, including illustrations and descriptions of the different kinds of clover seed, kinds and amounts of weed seeds found in different samples of clover seed examined, and illustrations and detailed descriptions of the different weed seeds.

Bulletin 48, pp. 10, figs. 15.—Some Ways of Seed Distribution.—A popular description of some of the methods by which seeds of weeds and other plants are distributed.

Bulletin 49, pp. 12, pls. 2, figs. 5.—The Carpenter Worm.—A description of the carpenter worm in its various stages, with notes on the injury done by this insect, and a discussion of remedial measures.

Bulletin 50, pp. 13, figs. 3.—Notes on Sugar Beets for 1899.—A brief report on several cooperative culture tests with sugar beets and general notes on the sugar-beet industry in the State.

GENERAL OUTLOOK.

Owing to the destruction of equipment and other facilities for work, but little scientific investigation has been conducted during the year. However, the difficulties arising from the fire will soon be overcome and already considerable interesting work has been outlined. This includes irrigation investigations, experiments in range improvement, chemical study of the nutritive and poisonous qualities of range plants, field work to determine the food plants of range sheep, and a soil survey of the State. In addition, a kind of institute work, or, more properly, an agricultural reconnoissance of the State is contemplated.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham.*

Department of New Hampshire College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Control: John G. Tallant (*Chair.*), *Pembroke;* Henry W. Keyes, *Haverhill;* George A. Wason, *New Boston;* Charles W. Stone (*Sec.*), *Andover;* Charles S. Murkland (*Pres.*), *Durham.*

STATION STAFF.

Charles S. Murkland, M. A., Ph. D., *President of the College.*
W. D. Gibbs, M. S., *Dir.; Agr.*
Fred W. Morse, M. S., *V. Dir.; Chem.*
Frank W. Rane, B. Agr., M. S., *Hort.*
Charles H. Pettee, M. A., C. E., *Met.*
Herbert H. Lamson, M. D., *Bact.*
A. Williams, *Asst. in Dairy Husb.*
Clarence M. Weed, D. Sc., *Ent.*
Harry A. Clark, B. S., *Asst. Chem.*
A. F. Conradi, *Asst. Ent.*
Frederick C. Keith, *Clerk.*
Harry F. Hall, *Gardener.*

LINES OF WORK.

The lines of work pursued at the New Hampshire Station during the past year have been much the same as in previous years. Attention has been given mainly to the study of silage and the ripening of fruits; field experiments, including tests of forage crops, rotation, tillage, and methods of using barnyard manure; feeding experiments with horses and dairy cows, including the keeping of individual dairy records; horticultural investigations, including tests of varieties of corn, potatoes, strawberries, and tomatoes, and experiments in forcing greenhouse crops; study of plant diseases and the bacteria and fungi causing changes in silage and the decay of fruits; entomological investigations, including experiments in the suppression of insect pests and studies of the life zones of the principal insects of the State; and the continuation of the comparison of different grades of gravel for roads.

The station is continuing chemical and bacteriological studies of apples with reference to the keeping qualities of different varieties, causes of decay, etc., under commercial cold-storage conditions. It is also making experiments in the improvement of old pasture lands and studies of the origin of red-clover seed in cooperation with the Bureau of Plant Industry of this Department. It continues to cooperate with the State board of agriculture in the inspection of fertilizers and the enforcement of laws relating to oleomargarine, but under a law passed by the State legislature, approved February 20, 1901, the inspection of oleomargarine and other food products, water supplies, milk, etc., will henceforth be in charge of the State Laboratory of Hygiene. The same legislature also amended the fertilizer law, making it conform more closely with the laws enforced in other New England States, and passed an act to regulate the sale of concentrated commercial feeding

stuffs, to take effect December 1, 1901. These laws are to be enforced by the secretary of the State board of agriculture, the station doing the chemical work and receiving out of the fees the actual cost of the work.

Numerous changes in the personnel of the station have occurred. C. W. Burkett, agriculturist, and his assistants, F. S. Johnston and H. B. Richardson, have resigned to accept similar positions in North Carolina and Indiana, respectively. Prof. W. D. Gibbs, of the Ohio State University, has been made director and agriculturist of the station, and several other changes have been made.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees, including balance from previous year	483.36
Total	15,483.36

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 76–79.

Bulletin 76, pp. 11, pl. 1, figs. 7.—Utilizing the Greenhouse in Summer.—A brief account of growing tomatoes, muskmelons, celery, cucumbers, sweet potatoes, eggplant, and peppers under glass in summer.

Bulletin 77, pp. 16, pl. 1, fig. 1.—Experiments in Road Surfacing.—Comparative tests during 2 years of various surfacing materials, including gravel of different kinds, screened and unscreened, clay, sand, point rock, and stones 2 to 6 inches through, applied during the spring of 1898, are reported, and the difference between macadam, gravel, and earth roads is briefly explained.

Bulletin 78, pp. 18, pl. 1.—Bovine Tuberculosis.—Brief popular notes are given on the cause, methods, and sources of infection, methods of transmission, diagnosis, and pathological lesions of this disease. The results of tuberculin tests applied to the college herd are tabulated, and experiments in inoculating milk of tuberculous cows into guinea pigs are reported.

Bulletin 79, pp. 38, pl. 1.—Annual Report, 1900.—This contains a financial statement for the fiscal year ended June 30, 1900, and departmental reports for the year ended October 31, 1900. The report of the vice-director and chemist contains analyses of sunflower seeds, several poultry foods, seaweed, and of maple sirup from defoliated trees, with notes on the different substances examined. The report of the horticulturist gives tabular data and descriptive notes on 60 varieties of

potatoes and 29 of tomatoes tested during the season. The report of the agriculturist includes a summary of the record of the college dairy herd during the year. The report of the bacteriologist gives notes on the decay of apples, with the results of experiments in cold storage, and a record of silo temperatures taken by electricity, with a description of the apparatus used. A subject list of station publications available for distribution and a summary of meteorological observations complete the report.

GENERAL OUTLOOK.

The efforts of the New Hampshire Station are directed toward the improvement of agricultural practice in that State. Farms are old, hence the importance of fertilizer investigations, tests of methods of renovating old orchards, and the experiments in the improvement of old meadows taken up in cooperation with farmers. Apples, strawberries, potatoes, hay, dairy products, and garden truck are staple products, and their culture and improvement hold leading positions among the subjects for investigation at the station. The transfer of part of the inspection work to the State Laboratory of Hygiene relieves the station staff of burdensome duties. The station was seriously crippled in its work during the summer by the resignation of the agriculturist and his two assistants, as well as by other staff changes. Several series of experiments covering a term of years have, however, been completed, and it is hoped that the results will be published before long.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

GOVERNING BOARD.

Board of Managers: Gov. Franklin Murphy, *Trenton;* Austin Scott, *New Brunswick;* Edward B. Voorhees, *New Brunswick;* Ephraim T. Gill, *Haddonfield;* Robert Gwynne, *Salem;* Winfield S. Bonham, *Shiloh;* John E. Darnell, *Masonville;* David D. Denise (*Pres.*), *Freehold;* James Neilson, *New Brunswick;* Samuel B. Ketcham (*V. Pres.*), *Pennington;* George Fritts, *Pattenburg;* Josiah Ketcham, *Belvidere;* James A. Burnett, *Hilton;* Abram C. Holdrum, *Westwood;* George H. Blakeley, *Paterson;* George E. DeCamp, *Roseland;* Cyrus B. Crane, *Caldwell;* George Dorer, *East Orange;* Ira C. Kilburn, *South Orange;* Rynier J. Wortendyke, *Jersey City;* Lucius F. Donohoe, *Bayonne;* John B. Williams, *New Durham;* Philip M. Brett, *Jersey City.*

STATION STAFF.

Edward B. Voorhees, D. Sc., *Dir.*
Irving S. Upson, M. A., *Chief Clerk; Sec. and Treas.*
Louis A. Voorhees, M. A., *Chief Chem.*
John P. Street, M. S., *Assoc. Chem.*
Alva T. Jordan, B. S., *Asst. Hort.*
Clarence B. Lane, B. S., *Asst. in Dairy Husb.*
Jacob G. Lipman, M. A., *Soil Chem. and Bact.*
Wm. P. Allen, B. S., *Asst. Chem.*
Mary A. Whitaker, *Sten. and Typewriter.*
Vincent J. Carberry, *Lab. Asst.*
Harry W. Williams, *Janitor.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

GOVERNING BOARD.

STATION STAFF.

Austin Scott, Ph. D., LL. D., *President of the College.*

Edward B. Voorhees, D. Sc., *Dir.*
Julius Nelson, Ph. D., *Biol.*
Byron D. Halsted, D. Sc., *Bot. and Hort.*
John B. Smith, D. Sc., *Ent.*
Wm. P. Allen, *Asst. Chem.*
James A. Kelsey, M. S., *Field Asst.*
Irving S. Upson, M. A., *Disbursing Clerk and Libr.*

Augusta E. Meske, *Sten. and Typewriter.*

LINES OF WORK.

The New Jersey State and College Stations continue to be under the supervision of the same director and to issue their publications in one series. Most of the work of these stations during the past year has been along the same lines as heretofore, including chemical studies of fertilizers and soils, feeding stuffs, and dairy products; meteorological observations; cultural experiments with orchard and small fruits, garden vegetables, ornamental plants, and lettuce and radishes under glass; an extended investigation of pear growing in the State; experiments with various forage crops, including soiling crops for dairy cows; rotation experiments with soiling crops; inoculation experiments with soy beans; experiments in feeding for milk and for fat; studies of abortion among dairy cows; observations on tuberculosis with special reference to detection, contagiousness, rapidity of development and curative action of repeated injections of tuberculin; biological studies of an intestinal disease of ducks; experiments with soil fungicides for potato and turnip diseases, including tests of the susceptibility of different varieties; studies of soil rot of sweet potatoes and club root of turnips; experiments with Nitragin and Alinit; investigations in shading; observations on the growth habits of weeds; experiments with asparagus rust and pear blight and the forcing of peaches; entomological investigations on plant lice, peach thrips, and insects injurious to orchard trees, small fruits, field crops, truck crops, and shade trees; experiments with insecticides, especially crude petroleum; extended investigations of the San José scale with special reference to distribution, remedies, and methods of application.

The last session of the State legislature appropriated $3,000 for the inspection of foods and feeding stuffs. The work was undertaken and carried out during the year by the State Station, and a bulletin containing the results of the study has been published. This appropria-

FIG. 1.—NEW JERSEY STATIONS—STALLS IN CATTLE BARN.

FIG. 2.—OREGON STATION—FRUIT EVAPORATOR.

tion has enabled the station to add a department of soil chemistry and bacteriology. For this new line of study the station has employed a special officer and is fitting up a laboratory with chemical and bacteriological apparatus. The station has erected a new silo for the study of summer silage and built an addition to the cattle barn (Pl. V, fig. 1), and the college has added to the equipment of the farm a new dairy building which will be used largely for experimental purposes. The biologist has again taken up the study of the oyster, and the entomologist is studying mosquitoes. Cooperation with this Office in irrigation investigations has been continued, and several new lines of work in cooperation with this Department have been undertaken, notably with the Bureau of Chemistry, on methods of analyzing insecticides and on the influence of environment on the sugar content of muskmelons; and with the Bureau of Soils, on soil investigation, and on various problems in making soil surveys and base maps. The inspection of fertilizers and of nurseries has been continued under State laws.

INCOME.

The income of the stations during the past fiscal year was as follows:

State station: State appropriation (fiscal year ended October 31, 1901)	$19,000
College station: United States appropriation	15,000

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 144–149.

Bulletin 144, pp. 39, pls. 16, figs. 13.—Live Covers for Country Homes.—A popular treatise on the more common hardy climbing vines used in this country for ornamental purposes and shade for houses and other buildings.

Bulletin 145, pp. 52.—Analyses and Valuations of Fertilizers.—A discussion of the cost, valuation, and purchase of fertilizers, home mixtures, special fertilizers, etc., and analyses and valuations of 47 samples of standard raw materials, 300 brands of complete fertilizers, 17 samples of home and special mixtures, 25 samples of ground bone, and 31 samples of miscellaneous products.

Bulletin 146, pp. 20.—Crude Petroleum v. the San José or Pernicious Scale.—A general summary of the results of experiments with crude petroleum as an insecticide against the San José scale conducted at the station since 1897.

Bulletin 147, pp. 8, figs. 2.—The Angoumois Grain Moth.—A

description of the appearance, life history, and habits of this insect with a discussion of preventive and remedial measures.

Bulletin 148, pp. 22, pls. 4.—Alfalfa, Methods of Culture and Yields per Acre.—Alfalfa Protein v. Purchased Protein in Rations for Dairy Cows.—This bulletin notes the growing importance of alfalfa on American farms, indicates methods of culture, points out the usefulness and value of the plant, and reports a test lasting 60 days with 4 cows, comparing alfalfa hay with wheat bran and dried brewers' grains in quantities furnishing practically the same amounts of protein.

Bulletin 149, pp. 17, pls. 2.—Two Strawberry Pests.—The strawberry-leaf roller (*Phoxopteris comptana*) and the strawberry-root louse (*Aphis forbesi*) are described; notes and observations are given on their life history, habits, natural enemies, etc.; and remedial measures are discussed.

GENERAL OUTLOOK.

The New Jersey stations are painstaking in everything undertaken, and are carrying on lines of investigation that have well-defined relations to the agriculture of the State. The improvement of soils, dairying, and fruit growing are subjects of growing importance that the stations are studying. Experiments in cylinders, begun in 1898 to determine the relative availability of nitrogen in barnyard manures and in the principal nitrogenous fertilizing materials, have been very satisfactory and have given results of considerable scientific value. In the botanical department work in hybridizing has been given a prominent place. The entomologist is making an investigation of mosquitoes, and has gathered evidence which indicates that if the salt marshes near the coast were drained the number of mosquitoes would be greatly reduced. It is hoped to make a practical test of this before long. The irrigation work while not giving such decisive results as formerly, owing to climatic conditions, shows increased yields in many cases where irrigation was used. The farm is in better condition than ever before, and is used for irrigation and plat experiments and the maintenance of a herd of dairy cows. The stations have established cordial relations with the farming population of the State and are doing a large amount of useful work.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, *Mesilla Park.*

Department of New Mexico College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Regents: L. Bradford Prince (*Pres.*), *Santa Fe;* P. H. Curran (*Sec. and Treas.*), *Las Cruces;* G. A. Richardson, *Roswell*; H. B. Holt, *Las Cruces;* Seaman Field, *Deming.* Advisory Members: Gov. Miguel A. Otero, *Santa Fe;* J. F. Chaves (*Supt. Public Instruction*), *Santa Fe.*

STATION STAFF.

Luther Foster, M. S. A., *President of the College and Director.*
Arthur Goss, M. S., A. C., *Chem.*
John J. Vernon, M. S. Agr., *Agr.*
E. O. Wooton, M. A., *Bot.*
John D. Tinsley, B. S., *V. Dir.; Soil Phys. and Met.*
Fabian Garcia, B. S., *Hort.*
R. Fred Hare, M. S., *Asst. Chem.*
Francis E. Lester, *Registrar.*
Helen M. Macgregor, *Sten.*

LINES OF WORK.

The work of the New Mexico Station during the past year has included feeding experiments with dairy cows to test the relative value of the available feeding stuffs of the Territory; tests of the feeding value of sweet corn, cabbage, and other forage crops; tests of grasses for pasturage and for alkali lands at the station and in other localities in the Territory; variety tests and methods of sowing wheat; variety tests, acclimatization, and methods of planting corn; fertilization, winter irrigation, and methods of seeding, cutting, and curing alfalfa; green manuring and soil correctives; studies on soil moisture in cooperation with the soil physicist; irrigation experiments, including studies on pumping, storage, etc.; tests of different varieties of apples, pears, plums, prunes, peaches, grapes, strawberries, gooseberries, and currants; methods of pruning fruit trees; prevention of sunscald; production of dried prunes; spraying to retard blooming period and to prevent injury by the codling moth; test of varieties and methods of culture of vegetables; tests of the adaptability of various ornamental shrubs and flowers; chemical analyses of samples submitted by people of the Territory; analyses of sugar beets, waters, and feeding stuffs; study of the ash content of native plants and of the soils of the Territory; observations on the salt and moisture content and other physical characteristics of soil planted to corn, orchard and forest trees, and alfalfa at the station and other places in the Territory; experiments in the propagation of grasses in cooperation with the Bureau of Plant Industry of this Department; and a study of the stock-raising industry of the Territory as related to the natural forage supply.

The Territorial legislature having failed to make provision for the substations, these have been abandoned. Provision has been made, however, for the issue of 5 per cent bonds to raise $25,000 for the construction, equipment, maintenance, etc., of college buildings; for providing a larger water supply; and for paying additional officers, some of which improvements will indirectly benefit the station. During the year the work of the main station has been considerably extended, especially in the agricultural department. The farm equipment has been improved by the construction of a pumping plant and corral and the purchase of 10 head of cattle. The vice-director has been given more immediate charge of the general business of the station. At the close of the fiscal year 1900 the president of the college and director of the station resigned, and in November of the present

year Prof. Luther Foster, vice-director, agriculturist and horticulturist of the Wyoming Station, was appointed to the position.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	5.30
Farm products	466.51
Total	15,471.81

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 32–37 and the Annual Reports for 1899 and 1900.

Bulletin 32, pp. 18.—Grasses and Forage Crops.—The importance of combining live-stock and crop interests is discussed, brief notes are given on grasses considered worthy of trial in New Mexico, and several culture and feeding experiments are reported in connection with a discussion of the following forage crops: Japanese barnyard millet, sorghum, Kafir corn, millo maize, alfalfa, and cowpeas.

Bulletin 33, pp. 17.—Notes from the San Juan Substation.—This contains a report on the successful culture of sugar beets and sorghum on alkali patches or "chico spots;" a brief account of an attempt to remove the soluble salts from an alkali spot by means of open ditches and flooding; results of rotation and fertilizer experiments with oats and corn; observations on tomato blight; brief statements concerning a practical test of the feeding value of several nonsaccharine sorghums; and notes on *Collops bipunctatus* as an enemy of the Colorado potato beetle.

Bulletin 34, pp. 54.—Principles of Water Analysis as Applied to New Mexico Waters.—This bulletin reports and discusses the results of the sanitary and mineral analyses of 148 samples of stream, spring, and well waters examined in the laboratory of the station during the past eight years.

Bulletin 35, pp. 27, figs. 10.—Observations on Insects.—Brief popular notes on a large number of injurious insects.

Bulletin 36, pp. 4.—Announcement to New Mexico Ranchmen and List of Bulletins.—Brief statements relating to the equipment and work of the station, a subject list of station publications, and the organization list of the station.

Bulletin 37, pp. 20.—Notes on the Food of Birds.—The economic relation of birds to agriculture is discussed in a general way, many special instances of the harmful or beneficial action of birds being cited, and notes are given on the feeding habits of a number of birds in New Mexico.

Annual Reports, 1899 and 1900, pp. 94.—Reports of the director and heads of departments reviewing the different lines of station work and financial statements for the fiscal years ended June 30, 1899 and 1900; also notes on the discovery of a deposit of bat guano in the Territory; list of publications of the entomologist, and reports of the superintendents of the San Juan and Las Vegas substations outlining work in progress.

GENERAL OUTLOOK.

The work of the New Mexico Station is assuming more definite form and is better planned. Its scope has been considerably extended, especially with reference to irrigation investigations and stock raising. In order to better understand the conditions of soil, water supply, timber and grazing interests of New Mexico, tours of inspection have been made to the southern and southeastern parts of the Territory. The difficulties of making satisfactory progress in studies on soil moisture and irrigation have been surmounted, it is hoped, by the construction of a windmill pumping plant with tank and storage reservoir. In this connection plans have been made for a thorough investigation of the best methods of irrigating from wells. The work of the station is better organized and in better condition than ever before, but the uncertainty regarding the head of the institution during several months of the summer and autumn, and the limited tenure of office of the men in charge of the work, has seriously interfered with its vigorous prosecution.

NEW YORK.

New York Agricultural Experiment Station, *Geneva.*

GOVERNING BOARD.

Board of Control: Stephen H. Hammond (*Pres.*), *Geneva;* W. O'Hanlon (*Sec. and Treas.*), *Geneva;* Gov. Benj. B. Odell, jr., *Albany;* A. C. Chase, *Syracuse;* F. O. Chamberlain, *Canandaigua;* F. C. Schraub, *Lowville;* Nicholas Hallock, *Queens;* Edgar G. Dusenbury, *Portville;* Oscar H. Hale, *North Stockholm;* Martin L. Allen, *Fayette.*

STATION STAFF.

W. H. Jordan, D. Sc., *Dir.*
Geo. W. Churchill, *Agr. and Supt. Labor.*
Wm. P. Wheeler, *Animal Indus.*
H. A. Harding, B. S., *Bact.*
L. A. Rogers, B. S., *Asst. in Bact.*
F. C. Stewart, M. S., *Bot.*
H. J. Eustace, B. S., *Asst. in Bot.*
L. L. Van Slyke, Ph. D., *Chem.*
C. G. Jenter, Ph. C., *Asst. Chem.*
W. H. Andrews, B. S., *Asst. Chem.*
J. A. Le Clerc,[a] B. S., *Asst. Chem.*
Fred B. Fuller, B. S., *Asst. Chem.*
Charles W. Mudge, B. S., *Asst. Chem.*
E. B. Hart, B. S., *Asst. Chem.*
Andrew J. Patten, B. S., *Asst. Chem.*
Geo. A. Smith, *Dairy Expert.*
Frank H. Hall, B. S., *Editor and Libr.*
Victor H. Lowe, M. S., *Ent.*
P. J. Parrott, *Asst. Ent.*
S. A. Beach, M. S., *Hort.*
N. O. Booth, B. Agr., *Asst. Hort.*
O. M. Taylor, *Foreman in Hort.*
F. E. Newton, *Clerk and Sten.*
Jennie Terwilliger, *Clerk and Sten.*
A. H. Horton, *Computer.*

[a] On leave.

LINES OF WORK.

The lines of work pursued at the New York State Station during the past year have been similar in general character and in many respects identical with those noted in previous reports. They include studies of the diseases of plants, especially treatment of asparagus rust, onion smut, and the black rot of cabbage and cauliflower; also investigations of raspberry cane blight and Rhizoctonia stem-rot diseases of various plants; entomological studies upon the life history and remedies for San José scale and tests of the effect of hydrocyanic-acid gas upon buds, flowering shrubs, and nursery stock, with other studies upon the life histories and remedies for the destructive pea louse, palmer worm, fruit-tree bark beetle, wheat sawfly, cherry fruit fly, wheat aphis, Hessian fly, and woolly aphis, and investigations upon the development of the sexual and parthenogenetic eggs of plant lice. Tests have been made of commercial fertilizers for onions; of systems of maintaining fertility, including the use of legumes, the necessity of the supply of ingredients in commercial fertilizers and comparison of commercial fertilizers and barnyard manure; foraging power of plants for phosphoric acid; nitrogen gathering power of legumes in ordinary conditions in good soil; influence of different forms of plant food upon the quality of fruit; effect of farm manures on the sugar content of sugar beets. Studies have been made on food sources of milk fat; metabolism in milch cows; influence of temperature and moisture upon loss of weight in curing cheese; influence of size of cheese upon loss of weight in curing; proteolytic changes taking place in cheese ripening under different conditions of temperature and moisture; separation and identification of proteid bodies formed in curing cheese; proteids in whey; proteolytic changes in milk inoculated with various micro-organisms; changes taking place in the production of cider vinegar; bacteriological studies and tests relating especially to cheese ripening and cheese faults; a study of enzym action of bacteria and galactase in cheese ripening.

Experiments have been conducted in poultry feeding in continuation of a series with special reference to the effect of mineral nutrients; others related to the use of bulky foods, limitations in the use of animal foods with ducklings, breeding experiments with poultry to study the effect of selection and inbreeding. Investigations have been conducted upon the self-fertility of the grape; in plant breeding, principally of grapes and small fruits; in thinning fruit; spraying in bloom; pollination of tomatoes in the forcing house; commercial fertilizers and stable manure for forcing lettuce and for apple orchards; irrigation for strawberries; propagation and culture of chestnuts; testing varieties of fruits, and in tillage *v.* mulching for strawberries.

The station has continued to cooperate with the Bureau of Chemistry

of this Department in testing sugar beets, and has arranged with the same bureau some work on dairy products. The work on rented land in different parts of the State has followed much the same lines as last year. The inspection of fertilizers, concentrated feeding stuffs and Babcock-test glassware, and the analysis of Paris green and other insecticides have been continued. The erection of a house for the director has proceeded and the building is approaching completion. The last legislature also granted an appropriation of $8,500 for repairs and alterations in fitting the present director's house and office for an administration building. The director has recently published a manual on The Feeding of Animals.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$1,500.00
State appropriation	87,119.82
Total	88,619.82

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 176–196 and the Annual Report for 1899.

Bulletin 176, pp. 22.—Inspection of Concentrated Commercial Feeding Stuffs during 1900.—Text and discussion of State legislation relating to the inspection of commercial feeding stuffs, list of brands licensed, and analyses of 118 samples of feeding stuffs collected in the spring of 1900.

Bulletin 177, pp. 62.—Report of Analyses of Commercial Fertilizers for the Spring and Fall of 1900.—Contains tabulated analyses of 450 different brands of commercial fertilizers.

Bulletin 178, pp. 6.—Inspection of Babcock Milk Test Bottles.—Requirements of the New York law relative to the testing of bottles used in the Babcock test at creameries and cheese factories, with the results of inspection.

Bulletin 179, pp. 10, pls. 3.—An Anthracnose and a Stem Rot of the Cultivated Snapdragon.—These two diseases are described and illustrated and the results of spraying experiments are given.

Bulletin 180, pp. 22, pls. 8, figs. 2 (Popular edition, pp. 8, pls. 2).—Miscellaneous Notes on Injurious Insects.—Economic and biologic notes on the forest tent caterpillar, the fruit-bark beetle, a mealy bug attacking quince trees, two apple-leaf miners, and the tarnished plant bug.

Bulletin 181, pp. 6, pls. 5.—A Fumigator for Small Orchard Trees.—A description of a fumigator devised at the station, with directions for using.

Bulletin 182, pp. 30, pl. 1 (Popular edition, pp. 8).—Experiments on the Sulphur-lime Treatment for Onion Smut.—General notes on the nature and treatment of onion smut, with the detailed results of field experiments, to test the value of sulphur and lime as soil treatments, and of experiments to determine the stage of growth at which infection occurs.

Bulletin 183, pp. 22 (Popular edition, pp. 9).—Notes on Some Dairy Troubles.—Flavor in milk and its products is briefly discussed, and investigations of a fishy flavor in milk, a bitter flavor in Neufchatel cheese, a sweet flavor in Cheddar cheese, and rusty spot in Cheddar cheese are reported.

Bulletin 184, pp. 10 (Popular edition, pp. 4).—The Influence of the Temperature of Curing upon the Commercial Quality of Cheese.—Notes on the cheese industry in New York, and reports of experiments in curing cheese at temperatures common under ordinary factory conditions and at lower temperatures.

Bulletin 185, pp. 10, pls. 4 (Popular edition, pp. 4, pls. 2).—The New York Apple-tree Canker).—A second report on investigations concerning the nature of this disease due to *Sphæropsis malorum.* The occurrence of the European canker in New York is also noted.

Bulletin 186, pp. 30, pls. 2, figs. 7 (Popular edition, pp. 11, pls. 2, figs. 2).—The Sterile Fungus Rhizoctonia as a Cause of Plant Diseases in America.—This bulletin gives the results of an investigation of this subject conducted by cooperation between the two New York stations. The characters of the fungus are given and some of the more destructive of the American forms are described.

Bulletin 187, pp. 18 (Popular edition, pp. 5).—Commercial Fertilizers for Potatoes.—Results for 1899 and 1900 of fertilizer experiments with potatoes carried on for four years on Long Island farms.

Bulletin 188, pp. 44, pls. 12.—Spraying for Asparagus Rust.—A description of asparagus rust, a review of various methods of treatment which have been recommended for the control of this disease, results of spraying experiments at the station with a modified form of Bordeaux mixture, and a detailed description of an apparatus devised especially for spraying asparagus.

Bulletin 189, pp. 6, fig. 1 (Popular edition, pp. 14, pls. 3).—A Little Known Asparagus Pest.—Economic and biologic notes on the asparagus miner (*Agromyza simplex*). The popular edition summarizes this bulletin with the preceding.

Bulletin 190, pp. 8.—Report of Analyses of Paris Green and Other Insecticides in 1900.—Analyses of 22 samples of Paris green and 5 of other insecticides.

Bulletin 191, pp. 42, pls. 5, map 1 (Popular edition, pp. 11, pls. 3.—A Fruit Disease Survey of Western New York in 1900.—Notes on different diseases of orchard and small fruits occurring in 18 counties in the western part of New York, the data being obtained from personal observations and from replies to circulars of inquiry sent to fruit growers.

Bulletin 192, pp. 18, pls. 6.—The Substitution of Soda for Potash in Plant Growth.—The results of previous investigations on this subject are briefly reviewed and an account is given of pot experiments carried on in a forcing house at the station during two winters.

Bulletin 193, pp. 18, pls. 6.—San José Scale Investigations. I, The Development of the Female.—Investigations here reported included experiments to determine the duration of the period of activity, rate of travel and mortality of larvæ, duration of the period of growth, and the effect of temperature on the development of larvæ. The different stages in the life history of the insect and means of distribution and control were studied.

Bulletin 194, pp. 16 (Popular edition, pp. 11, pls. 2).—San José Scale Investigations. II, Spraying Experiments with Kerosene Oil; Methods of Combating the San José Scale.—Experiments reported in detail in this bulletin were undertaken for the purpose of determining the effects of winter applications of kerosene oil on nursery trees and bearing trees, the percentage of oil necessary to kill scales in winter, and the effect of summer application on healthy trees. Brief notes are also given on the method of fumigation by hydrocyanic-acid gas and spraying with crude petroleum and whale-oil soap. The popular edition summarizes this bulletin with the preceding.

Bulletin 195, pp. 14.—Director's Report for 1900.—A review of the different lines of station work with results obtained, including also notes on the station staff, institute and inspection work, cooperative experiments, etc., and a subject list of bulletins published in 1900.

Bulletin 196, pp. 62, pls. 3, figs. 6 (Popular edition, pp. 15, pl. 1, figs. 5).—Spraying in Bloom.—Extensive field experiments as regards the effect of spraying fruit trees when in full bloom upon the yield conducted at the Cornell Station and at the State Station are reported, as is also a laboratory study of the effect of spray mixtures upon the germination of pollen and the growth of pollen tubes made at the State Station. Observations made at the State Station on the effect of spray mixtures on individual blossoms are reported and a description is given of the structure of an apple blossom and the process of setting fruit.

Annual Report, 1899, pp. 503, pls. 35.—This contains the organization list of the station, a financial statement for the year ended September 30, 1899, a meteorological record, and reprints of Bulletins 158–173 of the station.

GENERAL OUTLOOK.

This station has confined its investigations to lines of work closely connected with a few of the leading industries of the State. These are dairying, including cheese making; fruit raising, especially grapes; poultry raising; and plant production, including both field crops and garden vegetables, with closely related investigations on insects and diseases affecting fruits and plants. The work is well planned and carefully carried out and much of it is productive of valuable results. Farmers' institute work by station officers has been continued upon a satisfactory basis, which disseminates information regarding the work of the station throughout the State, and yet does not interfere materially with the regular work of inspection and investigation.

Cornell University Agricultural Experiment Station, *Ithaca.*

Department of Cornell University.

GOVERNING BOARD.

Board of Trustees—Station Council: Jacob G. Schurman (*Pres.*); Isaac P. Roberts, Franklin C. Cornell, John H. Comstock, Liberty H. Bailey, Emmons L. Williams.

STATION STAFF.

Jacob G. Schurman, B. A., D. Sc., LL. D., *President of the University.*

Isaac P. Roberts, M. Agr., *Dir.; Agr.*
George C. Caldwell, B. S., Ph. D., *Chem.*
James Law, F. R. C. V. S., *Vet.*
John H. Comstock, B. S., *Ent.*
Liberty H. Bailey, M. S., *Hort.*
Henry H. Wing, B. Agr., M. S., *Dairy Husb. and Animal Indus.*
G. F. Atkinson, M. S., *Cryptogamic Bot.*
Mark V. Slingerland, B. S., *Asst. Ent.*
Louis A. Clinton, B. S., *Asst. Agr.*
J. L. Stone, B. S. A., *Asst. in Agr.*
George W. Cavanaugh, B. S., *Asst. Chem.*
Clayton O. Smith, B. S., *Asst. in Cryptogamic Bot.*
O. F. Hunziker, B. S. A., M. S. A., *Dairy Bact.*
John Craig, B. S., *Extension Work in Agr. and Hort.*
Jas. A. Foord, B. S. A., *Asst. in Dairy Husb.*
Chas. E. Hunn, *Gardener.*
E. L. Williams, *Treas.*
E. A. Butler, *Clerk.*

LINES OF WORK.

The work of the New York Cornell Station during the past year has followed practically the same lines as in previous years, including variety experiments with wheat and sugar beets; comparisons of different legumes as soil renovators; experiments with commercial fertilizers on pastures; tillage and spraying experiments with potatoes; fertilizer and variety tests of buckwheat; tests of various plants as forage crops; plat experiments with grasses; feeding experiments with steers, pigs, and dairy cows; dairy investigations, including cheese making; breeding and feeding experiments with poultry; studies of the higher fungi, especially those of use as food plants; investigations of the fungus diseases causing decay of forest trees and shade trees;

spraying experiments; investigations of diseases of plants, including crown blight, root rot, and a disease of hops; studies in cooperation with the botanist at the Geneva Station on the sterile fungus Rhizoctonia as a cause of plant diseases in the State; chemical studies of soils, fertilizers, beets and their by-products in beet-sugar manufacture, ashes, butter colors, insecticides, and feeding stuffs; investigations on the life history of the palmer worm, peach borer, greenhouse leaf tier, strawberry pests, a grape pest new to the State, and a new beneficial insect, the common European praying mantis; and horticultural work, including studies of Japanese plums, the forcing of strawberries, tree fruits, and mushrooms, and investigations of methods of spraying.

The station continues to carry on an extensive system of cooperative experiments throughout the State with the aid of State funds. These experiments for the last year have been along six principal lines—renovation of apple orchards, trial of orchard cover crops, spraying of fruit trees when in blossom, culture of cabbage, garden beans, and muskmelons in western New York. The experience of five years in this work has demonstrated, among other things, that the apple orchard in New York State, when well cared for, is valuable property; that cover crops are effectual in maintaining orchard fertility, and that it is not wise to spray fruit trees during the blossoming period. During the year the horticulturist has published a book on the Principles of Vegetable Gardening and three volumes of his Cyclopedia of American Horticulture.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$13,500.00
State appropriation	[a] 12,131.69
Farm products, including balance from previous year	397.87
Total	26,029.56

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 183–192 and the Annual Report for 1900.

Bulletin 183, pp. 16, dgms. 2.—Sugar-beet Pulp as a Food for Cows.—A description and an analysis of sugar-beet pulp and the results of two feeding experiments with 11 cows.

[a] This is approximately the amount spent for experimental purposes out of an appropriation of $35,000 by the State for cooperative experiments and university extension work in agriculture.

Bulletin 184, pp. 16, pls. 3, figs. 4.—The Grape Root-worm, a New Grape Pest in New York.—Brief popular notes on the life history, habits, treatment, etc., of *Fidia viticida* reported as injurious to grapes.

Bulletin 185, pp. 16, pl. 1, figs. 2.—The Common European Praying Mantis, a New Beneficial Insect in America.—The occurrence of this insect in the State is noted and a brief account is given of its habits, life history, etc.

Bulletin 186, pp. 28, pls. 2, figs. 7.—The Sterile Fungus Rhizoctonia as a Cause of Plant Diseases in America.—This bulletin gives the results of an investigation of this subject conducted by cooperation between the two New York stations. The characters of the fungus are given and some of the more destructive of the American forms are described.

Bulletin 187, pp. 28, pls. 2, figs. 4.—The Palmer Worm.—An account of *Ypsolophus pometellus* as regards history, appearance at different stages, distribution, food plants, life history, natural enemies, remedial measures, etc., with a bibliography of the literature relating to this species.

Bulletin 188, pp. 12.—Spray Calendar.—Formulas and directions for preparation are given for the more important fungicides and insecticides.

Bulletin 189, pp. 24, pl. 1, figs. 2.—Oswego Strawberries.—Cooperative fertilizer experiments with strawberries carried on by the station and growers in Oswego for a period of three years are reported, methods of strawberry culture followed by Oswego growers are briefly outlined, and a short history is given of the development of the industry in Oswego, including some statistics of shipments to the larger markets in different years.

Bulletin 190, pp. 24, pls. 6, figs. 4.—Three Unusual Strawberry Pests and a Greenhouse Pest.—Descriptive and remedial notes based on observations and experiments at the station are given on *Cacœcia obsoletana*, two species of ground beetles (*Harpalus caliginosus* and *H. pennsylvanicus*), the white fly of the strawberry belonging to the genus Aleurodes, and the greenhouse leaf tier (*Phlyctœnia rubigalis*).

Bulletin 191, pp. 24, fig. 1.—Tillage Experiments with Potatoes.—The results of cooperative culture experiments with potatoes, including early or twice plowing, thorough fitting, deep planting, and level tillage conducted in 1899 and 1900 are summarized.

Bulletin 192, pp. 8, figs. 5.—Further Experiments Against the Peach-tree Borer.—Further tests of wire-cage protectors for keeping the peach-tree borer away from peach trees, wooden wrappers, and the gas-tar treatment are reported.

Annual Report, 1900, pp. 589, pls. 16, figs. 149, maps 2, dgms. 7.—The report proper includes the organization list of the station and brief reports on the work and expenditures of the station by the director,

treasurer, and heads of departments. Appendix I is made up of reprints of Bulletins 171–182 of the station. Appendix II gives a detailed statement of receipts and expenditures of the station for the fiscal year ended June 30, 1900. Appendix III contains reprints of publications on nature study.

GENERAL OUTLOOK.

Many of the important crops of the State are being studied by the station, especially from the point of view of field practice, as best suited to the different sections of the State, and special attention is being given to bringing the results of experimental work home to the farmer through the extensive system of cooperative experiments rendered possible by the State appropriation. The college with which the station is connected continues to be active in university-extension work in agriculture and in the effort to introduce nature study in the rural schools. The publication of the Nature Study Quarterly has been suspended, but the Junior Naturalist Monthly and the Reading Lessons for Farmers have been continued, and the publication of Reading Lessons for Farmers' Wives has been started. Both the cooperative experiments and the university-extension work have aided in bringing about the most cordial relations between the station and the people of the State, and this condition has been very helpful to the station, not only in facilitating the dissemination of information but also in furnishing an easy and reliable means of learning what the station can do for the farmer along investigational lines.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Agriculture: J. B. Coffield, *Everetts;* E. L. Daughtridge, *Rockymount;* William Dunn, *Newbern;* C. N. Allen, *Auburn;* J. S. Cunningham, *Cunningham;* A. T. McCallum, *Red Springs;* J. P. McRae, *Laurinburg;* L. G. Waugh, *Dobson;* W. A. Graham, *Machpelah;* A. Cannon, *Horseshoe;* J. R. Joyce, *Reidsville;* G. E. Flow, *Monroe;* J. C. Ray, *Boone;* Howard Browning, *Littleton.*

STATION STAFF.

George T. Winston, LL. D., *President of the College.*

B. W. Kilgore, M. S., *Dir.*
W. A. Withers, M. A., *Chem.*
C. W. Burkett, M. S., Ph. D., *Agr.*
W. F. Massey, C. E., *Hort.*
F. L. Stevens, Ph. D., *Bot.*
Franklin Sherman, jr., *Ent.*
Tait Butler, V. S., *Vet. and Animal Indus.*
G. S. Fraps, Ph. D., *Asst. Chem.*
H. P. Richardson, *Poultryman.*
B. S. Skinner, *Farm Supt.*
B. F. Walton, *Supt. Agr. Expt. Works.*
Mrs. E. V. Darby, *Sten.*

A. F. Bowen, *Bursar.*

LINES OF WORK.

The work of the North Carolina Station during the past year has included sugar-beet investigations in cooperation with the Bureau of Chemistry of this Department; studies on the availability of nitrogen in different forms, the effect of composting on plant food, and the minimum food requirements of corn, cotton, sweet potatoes, and a renovating crop; studies in animal nutrition, including determinations of the digestibility of various feeding stuffs and of the composition of cotton-seed meal; investigations on the determination of pentosoids; chemical work on ash analysis in cooperation with the Association of Official Agricultural Chemists of the United States and the Bureau of Chemistry of this Department; orchard work; experiments in the production of bulbs and roses for the Northern trade; studies of edible and poisonous mushrooms; studies and identification of fungus and bacterial diseases of cultivated crops, especially anthracnose on dewberries and a disease of summer cabbages known as "yellowsides;" entomological work; duplicate plat experiments with forage crops, cotton, peas, and soy beans on both old and new land to determine how best to restore lost fertility and how to conserve virgin fertility; fertilizer, cultural, and variety experiments with the principal farm crops; variety tests with grasses and sweet potatoes and experiments in the hybridization of orange trees in cooperation with the Bureau of Plant Industry of this Department. The station is cooperating with farmers in experiments with corn, cotton, and rice, and has undertaken cooperative experiments with the Bureau of Chemistry of this Department on the influence of environment on the sugar content of muskmelons. In cooperation with both the Bureau of Soils of this Department and the State department of agriculture, the station is conducting a soil survey to ascertain the definite location and extent of the type soil areas of the State.

During the year the station has been reorganized. The State legislature at its last session put both the college and station under control of the State board of agriculture. The president of the college retired from the directorship of the station and in accordance with his suggestion, B. W. Kilgore, chemist in charge of the State fertilizer inspection under the board of agriculture, was made director. The latter, however, will retain charge of the inspection. The agriculturist resigned and was succeeded by Dr. C. W. Burkett, of New Hampshire. The station staff was also materially strengthened by the appointment of a veterinarian in charge of animal husbandry, a botanist, and a poultryman.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	434.01
Miscellaneous	262.38
Total	15,696.39

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 171–178 and the Annual Report for 1900.

Bulletin 171, pp. 20.—Corn Culture in North Carolina.—This is a popular bulletin on corn culture, dealing in detail with the following subjects: Kinds of land suited for corn culture, preparation of the soil, planting, fertilizing, cultivation, rotations for corn, varieties best adapted to the South, harvesting the crop, selection and improvement of seed, protection against weevils and moths, and the comparative food value of corn and other forage crops.

Bulletin 172, pp. 36.—The Digestibility of Some Nonnitrogenous Constituents of Certain Feeding Stuffs.—The Purification of Phloroglucinol.—From data obtained in digestion experiments with sheep the digestibility of several nonnitrogenous constituents of feeding stuffs is estimated, the methods followed are described, and the work is discussed in relation to similar work elsewhere. A method for preparing phloroglucin free from diresorcin for use in the determination of pentosans is given.

Bulletin 173, pp. 12.—Another Warning in Regard to Compost Peddlers.—Defects in two fertilizer formulas offered for sale in the State are pointed out, farmers are cautioned against buying such formulas, and publications relating to fertilizers are recommended.

Bulletin 174, pp. 12.—Methods of Determining Proteid Nitrogen in Vegetable Materials.—A study of phospho-tungstic acid and bromin as precipitants for the proteids of vegetable materials is reported.

Bulletin 175, pp. 12.—Some New Species of the Genus Cratægus and Notes on Some Dichotomous Panicums.—Descriptions of 21 new species of Cratægus and 7 new species of Panicum.

Bulletin 176, pp. 10.—The Relative Value of Some Nitrogenous Fertilizers.—Experimental work at the station on the relative rate of nitrification of different fertilizers is reported and discussed in connection with a review of studies of the rate of nitrification of fertilizers and of the availability of nitrogenous fertilizers made elsewhere.

Bulletin 177, pp. 136.—Edible Mushrooms of North Carolina.—Notes are given on the food value of mushrooms, directions for their collection are given, and a number of the more important mushrooms occurring in the State are described.

Bulletin 178, pp. 16.—The Nature of Pentosoids and their Determination.—A summary of existing knowledge relating to pentosoids and a report of investigations concerning their properties and determination.

Annual Report, 1900, pp. 134.—This includes a report of the director on the work and publications of the station during the year; reports of the agriculturist, chemist, and the horticulturist, botanist, and entomologist, giving detailed outlines of the work of their respective departments; a financial statement for the fiscal year ended June 30, 1900, and reprints of Bulletins 170–174 of the station.

GENERAL OUTLOOK.

While devoting much attention to the farm crops now grown as staples in the State, the North Carolina Station is directing a greater effort than before to the improvement of the soil and the development of new industries. Information gathered from experiments with sugar beets has been compiled for publication. It shows that at least three, and probably thirteen, counties in the western part of the State are well adapted to the production of sugar beets, and that water, lime, and coal are available for the manufacture of sugar. Experiments during the past year with 15,000 rose cuttings from a Northern dealer indicate that the production of roses for the Northern trade can be made a profitable business. The production of flowering bulbs and early vegetables and fruits for the Northern trade is also receiving attention. The station is extending its influence by means of press bulletins and an extensive correspondence, and is establishing closer relations with leading farmers by means of cooperative experiments. The separation of the offices of president of the college and director of the station was a move in the right direction, as was also the bringing together of all experimental work under one management. For a number of years the State department of agriculture has been conducting a soil survey and experimental work in connection with its inspection work, and has established several experimental farms in different parts of the State. All of this work has now been combined with the station work under Director Kilgore and this, together with the anticipated strengthening of the station through funds obtained under the fertilizer law, makes the outlook for this station very promising.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*[a]

Department of North Dakota Agricultural College.

GOVERNING BOARD.

Board of Trustees: W. H. Robinson (*Pres.*), *Mayville;* B. N. Stone, *Lamoure;* John W. von Nieda (*Treas.*), *Fargo;* Henry J. Rusch (*Sec.*), *Fargo;* S. S. Lyon, *Fargo;* Alex. Stern, *Fargo;* Maynard Crane, *Cooperstown;* George E. Osgood, *Fargo.*

[a] Freight and express address, Fargo.

STATION STAFF.

J. H. Worst, LL. D., *President of the College and Director.*
E. F. Ladd, B. S., *Chem.*
H. L. Bolley, M. S., *Bot.*
J. H. Shepperd, M. S. A., *Agr.*
A. M. Ten Eyck, M. S., *Asst. Agr.*
C. B. Waldron, B. S., *Hort.*
H. M. Ash, *Farm Supt.*
C. E. Nugent, *Bookkeeper and Accountant.*

LINES OF WORK.

The work of the North Dakota Station during the past year has been along the same lines as heretofore and has included studies of the transformation of vegetable matter into humus and the formation and movements of nitrates in the soil, with accompanying studies of nitrifying bacteria; experiments to determine the loss of nitrates from leaching and to determine the amount of water required to produce 1 pound of dry matter in soils containing an abundant supply of plant food; a comparative study of timothy and brome grass for hay and pasture; selection experiments with corn and wheat to secure varieties with higher gluten content; also selection experiments with potatoes and flax; studies of plant diseases, especially flax wilt; plant breeding; rotation experiments; feeding experiments with horses and pigs, the latter for the utilization of waste products; horticultural investigations, including the cultivation of vegetables, small fruits, and apples, and experiments with forest trees, shelter belts, hedges, etc. Some work on the conservation of moisture and on varieties of grasses to bind the soil has been conducted at a substation at Edgely, with the aid of a small appropriation from the State. In connection with poultry work an egg record is being kept with a view to learning how to produce fertile eggs. Studies on the conservation of soil moisture are being made by cultivation and rotation and by the determination of the amount of moisture which a crop takes out and leaves in the soil.

During the year the station has furnished sugar-beet seed to about 1,600 farmers for cooperative work. Cooperation with the Bureau of Plant Industry of this Department includes experiments to determine the influence of the origin of red-clover seed on yield of crop and to improve the wheat industry of the Northwest. Further investigation of the so-called "flax sickness" has convinced the botanist that it is identical with the newly described disease known as "flax wilt," and is due to a fungus belonging to the genus Fusarium, which is rapidly distributed to new soils by means of seed flax, straw, manure, etc. Many experiments have been conducted to determine the various features in the life history of the fungus and some means of preventing its occurrence in the crop. Members of the station staff rendered assistance at a large number of farmers' institutes during the fall and winter. A farmers' institute law, which became effective July 1, 1901, carries an appropriation of $2,500 for two years and connects this

enterprise with the college. The excursions of farmers to the college have brought some 7,000 farmers to visit the institution during the past summer.

January 4, 1901, the large general-purpose barn was burned. This has been replaced by the erection of two barns at a total cost of $18,000. The college with which the station is connected has been given $50,000 for the erection of buildings, and has had its maintenance fund materially increased by the enactment of a law giving it a tax of one-fifth mill on each dollar of taxable property in the State.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,317.04
Miscellaneous	598.00
Total	16,915.04

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 44–46 and the Annual Report for 1900.

Bulletin 44, pp. 14, fig. 1.—Water Hemlock Poisoning.—Preserving Eggs.—A case of poisoning of two cows by water hemlock is reported and notes are given on the preservation of eggs with water glass. The bulletin is largely reprinted from an earlier publication of the station.

Bulletin 45, pp. 14.—Feeding Trials with Work Horses.—Results of feeding experiments with horses and mules in which timothy hay was compared with brome grass hay and with oat straw, and oats were compared with barley, malted barley, malted barley and bran, corn, and with bran and shorts.

Bulletin 46, pp. 94.—A Preliminary List of the Spermaphyta, Seed-bearing Plants of North Dakota.—A list with notes of the seed-bearing plants of the State, in which 340 genera and 775 species and varieties are enumerated.

Annual Report, 1900, pp. 119.—This includes a brief report on station work by the director; a financial statement for the fiscal year ended June 30, 1900; and departmental reports containing determinations of the nitrogen content of wheat, summaries of meteorological observations for 1900, notes on cooperative culture experiments with

sugar beets with tabulated analyses of a large number of samples, miscellaneous analyses, an account of work in the improvement of wheat by seed selection, investigations on the stinking smut of wheat relating especially to the effect of soil and weather conditions on the spores, the influence of smut in bread making, and treating the seed with formaldehyde and planting at different depths, a report of work in the selection of potatoes for seed with notes on experiments to determine the possibility of root fusion, studies relating to the uneven ripening of flax, a preliminary report of observations on a disease of flax designated as "flax wilt," results of experiments in the destruction of weeds by spraying, observations on the growth of weed seeds planted at different depths, details and results of tests including in some cases culture experiments of 63 varieties of wheat, 25 of oats, 25 of barley, 4 of spelt, 13 of millet, 4 of flax, 6 of buckwheat, 40 of potatoes, and 5 of beans, and tabulated results of experiments with wheat, corn, oats, barley, spelt, and flax to determine the effect of age and length of sprouts upon the vitality of seeds.

GENERAL OUTLOOK.

The work of the North Dakota Station has been directed mainly to the introduction of improved methods of farming and the development, acclimatization, and distribution of hardy varieties of cereals, forage plants, and fruits suited to the climate of the State. Considerable effort has been made to demonstrate the value of crop rotations, improved methods of cultivation, and stock raising in this region of frequent severe droughts. Much attention also has been given to breeding and selecting wheat, corn, fruits, and garden vegetables. One result has been the acclimatization of several varieties of dent corn and the extension of the successful cultivation of corn northward. Experiments with sugar beets during the past ten years have shown that the southern part of the State at least is adapted to the successful production of sugar, and efforts are now being made to determine the fitness of the soil and climate for the production of peas, beans, corn, and tomatoes for canning. The work of the station is meeting the approval of the farmers and they are coming to it in increasing numbers for advice and assistance.

OHIO.

Ohio Agricultural Experiment Station, *Wooster*.

GOVERNING BOARD.

Board of Control: Alva Agee (*Pres.*), *Cheshire;* F. Whittlesey, *Atwater;* D. D. White, *Castalia;* O. E. Bradfute (*Sec.*), *Cedarville;* D. L. Sampson (*Treas.*), *Cincinnati.*

STATION STAFF.

C. E. Thorne, M. S. A., *Dir.*
W. J. Green, *V. Dir.; Hort.*
J. F. Hickman, M. S. A., *Agr.*
F. M. Webster, M. S., *Ent.*
A. D. Selby, B. S., *Bot. and Chem.*
P. A. Hinman, *Bursar.*
John W. Ames, B. S., *Asst. Chem.*
John F. Hicks, *Asst. Bot.*
Wilmon Newell, M. S., *Asst. Ent.*
Clarence W. Waid, B. S., *Asst. Hort.*
J. C. Burneson, V. S., *Vet.*
William Holmes, *Foreman Farm.*
C. A. Patton, *Asst. Foreman and Met.*
Annie B. Ayres, *Mailing Clerk.*
Cary Welty, *Mechanic.*
Edward Mohn, *Supt. Substa.* (*Strongsville*).
Lewis Schultz, *Supt. Substa.* (*Swanton*).

LINES OF WORK.

The work of the Ohio Station during the past year has consisted principally in a continuation of investigations begun in former years, and has included investigations on the physical and chemical composition of soils and the conservation of moisture and fertility; variety and cultural experiments with field and garden crops, together with observations on the growth habits of different species; diseases of plants; entomology; comparison of different breeds of cattle and sheep; feeding experiments, with some investigations on the nutrition of animals and studies of the diseases of animals. The station continues to cooperate with this Department in work on sugar beets and tuberculosis. Studies of problems in the maintenance of soil fertility are conducted on a large scale in five different parts of the State. The horticulturist has been giving special attention to experiments in mulching, irrigation of field plats with pipes, and subirrigation in the greenhouse. The entomologist has made a comprehensive study of the use of kerosene as a spray, and has also paid considerable attention to the use of the Sporotrichum fungus for destroying the chinch bug.

Under a special appropriation made by the State legislature the station has conducted an investigation on the prevalence of bovine tuberculosis throughout the State, the results of which indicate that while a majority of the cattle of the State are free from this disease, yet it exists in many herds. The tuberculin for this investigation is furnished by the Bureau of Animal Industry of this Department. A late rot of the grape, possibly the white rot, has wrought great destruction to the grape industry of the lake region in Ohio. The station carried on experiments in that region during the past summer which resulted in saving 97 per cent of the grapes in vineyards treated, whereas in untreated vineyards the crop was practically all destroyed. The orchards planted by the station upon its removal to Wooster are now coming into bearing, and the station made an exhibit of fruits from these orchards at the last State fair. The inspection of nurseries and orchards, in charge of the entomologist, has been continued with a State appropriation of $15,000 for the years 1900 and 1901. The substations at Strongsville and Swanton have been continued at State expense.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,317.04
Miscellaneous	598.00
Total	16,915.04

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 112–126 and the Annual Report for 1900.

Bulletin 112, pp. 8, pl. 1, map 1.—The Clover-root Borer.—Descriptive and remedial notes on *Hylastes obscurus*, with the results of an experiment in plowing immediately after harvesting the first crop of clover for the destruction of this insect.

Bulletin 113, pp. 14, pls. 6.—Plums—A Comparison of Varieties.—Descriptive notes are given on the 175 varieties of plums which have been tested at the station. The varieties are classified into groups and the groups characterized.

Bulletin 114, pp. 10, pls. 2, fig. 1.—How Insects are Studied at the Ohio Agricultural Experiment Station.—A popular account of the insectary and breeding cages at the station, and of methods of collecting, rearing, preserving, and labeling insects.

Bulletin 115, pp. 20.—Sugar Beet and Sorghum Investigations in 1899.—Results of cooperative culture experiments with sugar beets in 1899, including tabulated analyses of 131 samples; and of cooperative experiments with sorghum, in which seed of 5 varieties was distributed to 122 farmers in 54 counties of the State for the purpose of comparing varieties and securing seed for future crops.

Bulletin 116, pp. 4, pl. 1.—The Grape-cane Gall Maker and its Enemies.—Observations on the life history and natural enemies of this insect, with suggestions as to preventive measures.

Bulletin 117, pp. 14, pl. 1.—Stomach Worms in Sheep.—A description of a stomach worm (*Strongylus contortus*) causing serious losses of sheep in Ohio since 1896, and an account of experiments to test the benzine or gasoline treatment for this worm and to determine the method of infection.

Bulletin 118, pp. 26.—Field Experiments with Wheat.—Detailed data for 1899 of variety tests and various culture experiments with wheat and average results each year from 1893 to 1899.

Bulletin 119, pp. 10, map 1.—The Hessian Fly in 1899 and 1900.—Notes on the damage done by the Hessian fly in Ohio during the fall of 1899 and the spring of 1900, and on the influence of meteorological

conditions on the development of this insect, with suggestions for growing wheat so as to lessen the danger from this source.

Bulletin 120, pp. 32.—Meteorological Summary.—Press Bulletins.—A summary of meteorological observations during 1899 and for comparison similar data for previous years; and reprints of the press bulletins issued during the year which have not already been incorporated in the regular bulletins.

Bulletin 121, pp. 70, figs. 54.—A Condensed Handbook of the Diseases of Cultivated Plants in Ohio.—Includes a popular discussion of some of the causes of plant diseases and the means by which they are spread, descriptions of the more common diseases observed as occurring in Ohio, directions for the preparation and use of fungicides and insecticides, and a spray calendar.

Bulletin 122, pp. 14, pl. 1, figs. 2.—Onion Smut—Preliminary Experiments.—A preliminary account is given of experiments conducted for the prevention of onion smut, together with notes on the onion-smut fungus and its distribution and manner of infection, and general suggestions for the treatment of this disease.

Bulletin 123, pp. 18, pl. 1.—Grape Rots in Ohio.—Experiments in the Prevention of Grape Rot.—An account is given of the various grape diseases, especial attention being paid to the black rot and the white rot, and spraying experiments with Bordeaux mixture, formalin, salicylic acid and lime, salicylate of soda, and copper sulphate for the prevention of grape rot are reported.

Bulletin 124, pp. 18.—The Maintenance of Fertility.—Details and results of a large number of field experiments with a variety of fertilizers. The work is in continuation of investigations on the maintenance of fertility reported upon in earlier publications of the station.

Bulletin 125, pp. 12.—The Maintenance of Fertility.—Experiments similar to those noted above, comparing superphosphate, muriate of potash, nitrate of soda, and dried blood applied in different amounts and combinations for potatoes, are reported. A rotation for potatoes was studied in this connection.

Bulletin 126, pp. 42, pls. 5, fig. 1.—Sugar-beet Investigations in Ohio in 1900.—A report on cooperative culture tests with sugar beets throughout the State, including the results of germination tests of the beet seed used, meteorological data for the year and for previous seasons, a discussion of the beet-sugar industry in Ohio, a description of the beet-sugar factory, and notes on sugar-beet culture and on the more important diseases of sugar beets.

Annual Report, 1900, pp. 29.—This contains the organization list of the station; a financial statement for the fiscal year ended June 30, 1900; a report of the director reviewing the work of the station during the year, discussing the relation of the station to the agriculture of the State, and giving a list of acknowledgments, and the text of the orchard and nursery inspection law.

GENERAL OUTLOOK.

The Ohio Station continues to devote considerable effort to the solution of problems in the maintenance of soil fertility, and the result of applying different fertilizers during the past year has shown striking contrasts. It has been shown that barnyard manure taken fresh from the stalls and applied to corn is worth about 50 cents more per ton than that which has lain in a level open yard during the winter. The addition of gypsum or kainit to the manure a few weeks before its application increases its effectiveness, and still greater effectiveness is produced by the addition of acid phosphate and of finely ground unacidulated rock known as "floats." Of greater importance is the fact that the yield from the use of unacidulated floats is quite as large as that from an equal weight of acid phosphate, thus indicating the possibility of dispensing with the acidulation of phosphate rock, providing it be finely ground and used in connection with barnyard manure. The feeding experiments at the station have been brought to a point where the results of several years' comparative study of different breeds of cattle may be compiled for publication.

The work of the Ohio Station has been organized upon a plan which contemplates a long series of investigations upon a few principal lines of research, hence the importance of the results attained from year to year depends largely upon the result of the whole series of investigations. The inspection of nurseries under a State law has been organized separately from the general business of the station, and has proved a task of much greater magnitude than was anticipated. Difficulties in the administration of this station have of late been a serious hindrance to its work. The duties of the director should be more clearly defined, and he should be made fully responsible for the direct management of the station, subject to the general policy established by the board of control.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater.*

Department of Oklahoma Agricultural and Mechanical College.

GOVERNING BOARD.

Board of Regents: F. J. Wikoff (*Pres.*), *Stillwater;* Gov. T. B. Ferguson, *Guthrie;* H. G. Beard, *Shawnee;* T. J. Hartman (*Treas.*), *Deer Creek;* H. C. R. Brodboll, *Ponca;* W. H. Merten, *Guthrie.*

STATION STAFF.

Angelo C. Scott, M. A., LL. M., *President of the College.*

John Fields, B. S., *Dir.; Chem.*
L. L. Lewis, M. S., D. V. M., *Vet.*
F. C. Burtis, M. S., *Agr.*
W. R. Shaw, Ph. D., *Bot. and Ent.*
Oscar M. Morris, B. S., *Assoc. Hort.*
A. B. McReynolds, B. S., *Asst. Chem.*
J. S. Malone, B. S., *Asst. Agr.*
H. M. Hand, *Clerk.*

Miss G. M. Holt, *Sten.*

LINES OF WORK.

The work of the Oklahoma Station during the past year included the continuation of investigations begun in previous years and the beginning of some new lines of work. Digestion experiments with Kafir corn and its products were continued, as were also determinations of the yield of digestible nutrients by a number of fodder crops; feeding experiments with steers and pigs; studies of methods of wintering and summering yearling steers; cultural and variety experiments with wheat; experiments in pasturing wheat; experiments in continuous cropping of wheat and Kafir corn; three-year and five-year rotation experiments with and without manuring; fertilizer and culture experiments with alfalfa; studies of the flora of the Territories; studies of the crown knot of the apple, and of a destructive root rot of fruit trees; forestry experiments in cooperation with the Bureau of Forestry of this Department; horticultural investigations, especially with orchard and small fruits, and variety and cultural experiments with potatoes. Experiments with chickens under average farm conditions were continued and similar experiments with ducks begun, and to the investigations on blackleg, Texas fever, and animal parasites have been added investigations on hog cholera, swine plague, and contagious abortion. Experiments have been begun in the improvement of castor beans by selection and in the improvement of native grass pastures by introducing new grasses. The legislature at its last session appropriated $54,000 for college and station buildings. These will include a new barn for the joint use of college and station, and a college building which will furnish better quarters for the station departments of botany and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	2,924.84
Total	17,924.84

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 46–50 and the Annual Report for 1900.

Bulletin 46, pp. 8.—Digestion Trials.—Results of experiments with chickens to test the digestibility of corn, Kafir corn, and cowpeas; and of experiments with sheep to test the digestibility of corn, Kafir corn, sorghum, black-rice corn, and millo maize.

Bulletin 47, pp 48.—Reports of Wheat Raisers.—Experiments with Wheat.—Summaries of replies from 118 farmers to circulars of inquiry sent out by the station requesting information regarding wheat farming in the Territory, and details and results of experiments with wheat in 1900, consisting of early, medium, and late plowing; early medium, and late seeding; growing wheat continuously on the same soil with and without manure, and tests of varieties.

Bulletin 48, pp. 11.—Crop and Forage Notes, 1900.—This bulletin contains a report on the various crops under test at the station in order to determine suitable varieties, the best adapted soils, and the most desirable methods of cultivation.

Bulletin 49, pp. 32, pls. 11 (Popular edition, pp. 11, pls. 2).—A Rhizomorphic Root Rot of Fruit Trees.—Investigations on a root rot of fruit trees considered due to a new species of fungus, to which the name *Clitocybe parasitica* is given, are reported. The distribution of the disease is noted, the fungus is described, and preventive and remedial measures are suggested. An extensive bibliography is included.

Bulletin 50, pp. 11.—Manuring the Soil.—A popular discussion of this subject.

Annual Report, 1900, pp. 141, pls. 2, figs. 20.—This includes a report of the director on the work, publications, and staff of the station; a paper on the work of the experiment station; popular notes on the nature and treatment of Texas fever and hog cholera; a general discussion on diversified farming in Oklahoma, including suggestions on the culture of various crops; a summary of a large number of press bulletins issued by the station; results of the examination of 141 mineral specimens; analyses of 18 samples of water; a discussion of the principles of wine making, with analyses of 17 samples of Oklahoma wines; results of a test, with 20 steers, of the comparative feeding value of corn and Kafir corn fed with alfalfa hay and Kafir corn stover; a popular discussion of the propagation, cultivation, pruning, and trellising of grapes; brief descriptions of several diseases of grapes, with suggestions for their prevention; descriptive and remedial notes on various insects affecting grapes; a list of the varieties of fruits being tested at the station; notes on work in tree planting; a general article on feeding farm animals, with tables showing the composition of common feeding stuffs; a financial statement for the fiscal year ended June 30, 1900; and a list of the publications issued since the organization of the station.

GENERAL OUTLOOK.

The work of the Oklahoma Station is well directed and is confined to a few important lines bearing upon animal husbandry, including crop and forage experiments and the study of animal diseases, and

upon fruit growing and the development of diversified farming. In fruit growing the number of variety tests is being reduced and more attention is given to diseases, methods of culture, and management. The work in forestry has pointed out some of the most desirable trees to plant for the cheap and rapid production of material for fence posts and fuel. Press bulletins and popular bulletins on the work of the station and on methods employed by the leading farmers of the Territory meet with popular approval, and a plan now being formulated for general cooperative work with persons in different sections of the Territory in the study of plants, insects, and fungus diseases gives promise of valuable results. On account of its importance and the peculiar difficulties which are presented, the potato crop is receiving a large share of attention. Wheat also is an important crop that is claiming much attention from the station, and Bulletin 47, Reports of Wheat Raisers and Experiments with Wheat, is in great demand. The mailing list of the station has increased to such an extent that it was necessary to print 20,000 copies of the Annual Report for 1900–1901. During the year station officers assisted at five successful farmers' institutes.

OREGON.

Oregon Experiment Station, *Corvallis.*

Department of Oregon State Agricultural College.

GOVERNING BOARD.

Board of Regents: J. K. Weatherford (*Pres.*), *Albany;* John D. Daly (*Sec.*), *Corvallis;* B. F. Irvine (*Treas.*), *Corvallis;* W. E. Yates, *Corvallis;* Gov. T. T. Gerr, *Salem;* F. I. Dunbar (*Sec. State*), *Salem;* J. H. Ackerman (*State Supt. of Public Instruction*), *Salem;* W. P. Keady, *Portland;* Benton Killin, *Portland;* J. M. Church, *Lagrande;* John D. Olwell, *Central Point;* B. G. Leedy, *Tigardville.*

STATION STAFF.

Thos. M. Gatch, M. A., Ph. D., *President of the College.*

James Withycombe, V. S., *Dir.; Agr.*
George Coote, *Floriculture and Gard.*
A. B. Cordley, M. S., *Ent.*
E. R. Lake, M. S., *Hort. and Bot.*
A. L. Knisely, M. S., *Chem.*
Frank E. Edwards, B. M. E., *Asst. Chem.*
C. M. McKellips, M. S., Ph.C., *Asst. Chem.*
F. L. Kent, B. S. Agr., *Asst. Agr. and Dairy.*
E. F. Pernot, *Bact.*
T. H. Crawford, M. A., *Clerk and Purchasing Agent.*

Helen L. Holgate, *Sten.*

LINES OF WORK.

The work of the Oregon Station during the past year has included soil investigations to determine losses of nitrogen by leaching, chemical changes developed by different systems of rotation, the value of decomposed granite as a source of potash and its effect on the texture and

acidity of the soil, conservation of moisture, etc.; variety tests with cereals, forage crops, and garden vegetables; feeding experiments with sheep, swine, and dairy cows; dairy investigations; chemical studies with fruits, vinegars, forage crops, silage, plant foods, and soils, etc.; entomological investigations; bacteriological studies of diseases of poultry, sheep, goats, and calves, and with vinegars, yeasts, smuts, sheep dips, and milk; horticultural and botanical investigations, including plant breeding, root pruning and grafting, fruit preservation, protection by means of sheaths for the trunks of young orchard trees, and studies of native clovers, grasses, and poisonous plants.

The variety tests are conducted for the purpose of introducing grains adapted to the peculiar conditions of the region and forage plants capable of augmenting the protein-yielding feeding stuffs of the farm. The dairy instructor is studying the keeping qualities of separated milk, effect of pasteurization, methods of testing milk, and other dairy problems. The division of entomology and plant diseases has investigated a serious outbreak of the variegated cutworm (*Peridromia saucia*), continued the work on apple-tree anthracnose, brought to a conclusion the work of several years on the codling moth, and begun a study on the nature of prune-leaf curl. A study of foreign hops grown under local conditions has been undertaken. The station is cooperating with the Bureau of Plant Industry of this Department in experiments with sand-binding grasses, plants poisonous to live stock, and red clover to determine the influence of the origin of seed on the yield of crop. Cooperative experiments with legumes at Moro, in eastern Oregon, have been continued. The station conducts farmers' institutes with funds furnished by the State. A new evaporating plant (Pl. V, fig. 2) well equipped for technical and scientific work has been completed, and investigations in fruit evaporation and the utilization of secondary products of the orchard have been undertaken. The station chemist, entomologist, and bacteriologist have been released from college duties in order that they may devote their whole time to station work.

The State legislature at its last session appropriated $5,000 a year for two years for the establishment of a State experiment station in eastern Oregon, to be under the supervision of the station at Corvallis. The site chosen is at Union, Union County, where 640 acres of State land have been turned over to the station, and work in growing forage crops has been started. For the present this will be a seed-growing station to distribute seeds to ranchers in a cooperative way for the purpose of encouraging forage production and range improvement. Later, problems in stock feeding will be taken up. The farm buildings include a house and barn. A $3,000 station building for offices and storeroom will soon be erected.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	3,044.02
Total	18,044.02

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 63–65 and the Annual Reports for 1896, 1898, 1899, and 1900.

Bulletin 63, pp. 10.—A Preliminary Bulletin on the Prevention of Smut on Oats.—A preliminary report of a series of experiments on the prevention of smut in which seed oats were treated with solutions of copper sulphate and zinc sulphate, hot water, formalin, and sterilized dry hot air.

Bulletin 64, pp. 14, pl. 1, figs. 3.—Investigation of Diseases in Poultry.—An account of observations and investigations on the nature and treatment of avian tuberculosis, catarrhal roup, favus, scabies, pneumonia, congestion of the lungs, and indigestion.

Bulletin 65, pp. 36, pls. 3.—Creameries and Cheese Factories of Western Oregon.—Information on the organization and operation of some 70 creameries and cheese factories in western Oregon, inspected by the author of the bulletin, with miscellaneous notes on the Babcock test, feeding and production of cows in the State, packing and marketing butter, etc.

Annual Report, 1896, pp. 30.—Notes on the work and needs of the station and a financial statement for the fiscal year ended June 30, 1896.

Annual Report, 1898, pp. 68.—This contains a brief review of station work by the director; a financial statement for the fiscal year ended June 30, 1898; a report of the agriculturist, reviewing the work of the year and summarizing the results of experiments reported in previous publications of the station; a report of the chemist, containing miscellaneous analyses; a report of the entomologist, giving notes on various insects studied during the year; a report of the botanist, giving brief notes on Oregon weeds, plant diseases, native clovers, parasitic fungi, etc., and a report of the horticulturist, outlining the experiments undertaken during the year.

Annual Report, 1899, pp. 36.—A report of the director, a financial statement for the fiscal year ended June 30, 1899, and reports of the heads of departments reviewing the different lines of station work,

and giving briefly some of the results obtained, including miscellaneous chemical analyses.

Annual Report, 1900, pp. 32.—A report of the director, a financial statement for the fiscal year ended June 30, 1900, outlines of station work by the heads of departments, and results of cooperative experiments with sorghum.

GENERAL OUTLOOK.

The station is wisely directing considerable effort to the development of means for advancing the important fruit interests of the State. The utilization of secondary fruit products is an important factor for the fruit grower to consider, and is well worthy the attention of the station workers. The efforts of the station to introduce stock raising and dairying as a means for diversifying farm operations in the grain-producing sections are also praiseworthy and have met with encouraging results. The station is making a vigorous campaign against summer fallowing and is trying, with considerable success, to introduce the growing of legumes to improve soils. Much of the station work is being vigorously and intelligently carried on and the institution is growing in public favor. The college with which it is connected has recognized the increasing importance of its investigations by releasing several members of the staff from all college work, and the prospect for good work in the future is very promising. The division of dairying should have an equipment better adapted to station purposes, to the end that a larger amount of investigation in this line may be conducted. The offices of president of the college and director of the station have recently been separated.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station, *State College.*

Department of the Pennsylvania State College.

GOVERNING BOARD.

Board of Trustees—Advisory Committee: John A. Woodward (*Chair.*), *Howard;* Joel A. Herr, *Cedar Springs;* H. V. White, *Bloomsburg;* Samuel R. Downing, *Goshenville;* George W. Atherton, *State College;* H. P. Armsby (*Sec.*), *State College.*

STATION STAFF.

George W. Atherton, LL. D., *President of the College.*

H. P. Armsby, Ph. D., *Dir.*
William Frear, Ph. D., *V. Dir.; Chem.*
William A. Buckhout, M. S., *Bot.*
Geo. C. Butz, M. S., *Hort.*
George C. Watson, M. S., *Agr.*
Harry Hayward, B. S., *Dairy Husb.*
William C. Patterson, *Supt. Farm.*
Julia C. Gray, *Sec.*
J. A. Fries, B. S., *Asst. Chem.*
C. A. Browne, jr., M. A., *Asst. Chem.*
C. W. Norris, *Asst. Chem.*
Milton S. McDowell, *Asst. Chem.*
M. H. Pingree, B. S., *Asst. Chem.*
Nathan W. Buckhout, *Asst. Chem.*
James P. Pillsbury, *Asst. in Hort.*
A. K. Risser, *Asst. in Agr.*
W. T. Carter, B. S., *Fellow in Agr. Chem.*
Thorne M. Carpenter, *Asst. Chem.*

LINES OF WORK.

The work of the Pennsylvania Station during the past year has included studies of dried brewers' grains, pentosans, the humus content of soils, and methods of analyzing cattle feeds and timothy hay; fertilizer, variety, rotation, and cultural experiments with field crops; fertilizer, cultural, and curing experiments with tobacco; comparisons of soiling crops; botanical study of the influence of smoke and gases upon vegetation for the State department of agriculture; investigations in dairying, including bacteriological studies, an experiment in feeding dehorned cows loose in their pens, and investigations in breeding and selecting dairy cattle; and horticulture, especially variety tests, studies of San José scale and crown gall, and experiments in the use of hydrocyanic acid for the destruction of insects and fungi in greenhouses. The station has continued to cooperate with the State department of agriculture in the inspection of fertilizers, feeding stuffs, and seeds, and in experiments in watering and handling fattening steers.

During the past year a new series of experiments with forage crops, with special reference to their value as soiling crops for feeding dairy cattle, was inaugurated. Closely related to these experiments is a study of the value of manure from fattening cattle and the proportion of it recovered by different methods of handling. The station has taken up the examination of food products for the State dairy and food commission. During the year Prof. W. W. Cooke, formerly of the Colorado Agricultural College, has carried on at this station an interesting investigation upon the relative value of grain as compared with coarse fodder in the maintenance ration of sheep; also a study of fermentations in the digestive canal of ruminants, which seems to indicate that the present accepted views on that subject need more or less revision. The agriculturist of the station has published in the Rural Science Series a book on Breeds of Poultry. The respiration calorimeter constructed for investigations on the nutrition of large animals, in cooperation with the Bureau of Animal Industry of this Department, is practically completed and preliminary alcohol tests have been quite satisfactory. Great ingenuity and skill have been shown in the construction of this large and complicated apparatus and great interest will attach to its experimental use. Members of the station staff devote considerable time to the work of farmers' institutes, State and county fairs, and other lines of public service not directly connected with the work of the station proper.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	8,355.00
Farm products	4,723.97
Miscellaneous	95.46
Total	28,174.43

A report of the receipts and expenditures of the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 52–54 and the Annual Report for 1899.

Bulletin 52, pp. 8.—Rye Meal and Quaker-oats Feed for Milk Production.—Report of an experiment covering 3 periods of 35 days each conducted with 9 cows to compare Quaker-oat feed and rye meal as feeding stuffs for milch cows.

Bulletin 53, pp. 8.—Methods of Steer Feeding.—Report of a cooperative experiment made by the station and the Pennsylvania department of agriculture to determine the comparative merits of feeding steers in pens and stalls.

Bulletin 54, pp. 7.—The Manurial Value of the Excreta of Milch Cows.—A record of the amount and composition of food eaten and of feces and urine excreted and milk produced by 2 cows during 50 days.

Annual Report, 1899, pp. 343, pls. 8, dgms. 23.—This includes the organization list of the station; a financial statement for the fiscal year ended June 30, 1899; a report of the director summarizing briefly the work of the station during the year; data on the cost of growing and the yield of dry and digestible matter per acre of corn, sugar beets, and mangels, and the results of a feeding experiment with 9 cows to determine their comparative value as dairy foods; details and results of 2 tests with 14 calves to determine the value of whole milk for the production of veal; a report of experiments begun in the fall of 1896 in cooperation with the Division of Forestry of this Department to study the effect of climate upon several widely distributed species of forest-tree seedlings; observations on the time and rate of formation of the annual ring of wood in the European larch and the white pine; notes on the depreciation of forest trees and results of the failure to cut trees at maturity; miscellaneous notes on diseases of oaks, the pine weevil, and shade trees for street planting; meteorological observations; lists of exchanges and available station publications; and reprints or more detailed accounts, including full experimental data of work reported in Bulletins 44–52 of the station.

GENERAL OUTLOOK.

The Pennsylvania Station has persistently followed a few main lines of investigation. One series of experiments in particular, namely, four-course rotations, has been conducted upon a uniform plan for the past nineteen years. These experiments involve the use of 144 plats of one-eighth acre each, and are probably the most extensive and long-continued experiments of the sort in the United States. Dairy hus-

bandry is a subject that has been given a leading place in the investigations of this station. The results, now nearly ready for publication, of three investigations upon the influence of protein supply upon milk production seem to indicate that some material modification of current views regarding the importance of a narrow nutritive ration in the feeding of dairy cattle will be necessary. Another closely related subject, animal nutrition, has received attention ever since the organization of the station. The completion of the respiration calorimeter will give this subject even greater prominence than before. The station is doing good work, but owing to lack of funds it is unable to meet all demands made upon it for inspection service, correspondence, and other routine work, and at the same time inaugurate and conduct new lines of research, however much the latter may be needed.

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Rio Piedras, near San Juan.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

F. D. Gardner, *Special Agent in Charge.* O. W. Barrett, *Ent. and Bot.*
James Mackinlay, *Farm Foreman.*

LINES OF WORK.

The work of the Porto Rico Station during the past year has included an agricultural survey of the island, comprising an inquiry into the condition of the various agricultural industries, soils, rivers, drainage, forests, roads, manufactures, wages, markets, education, and climate, by Prof. S. A. Knapp, of Louisiana, under instructions from the Director of this Office; also, a study of the agricultural conditions and possibilities of the island by Mr. F. D. Gardner, formerly of the Division of Soils of this Department, who was appointed in April, 1901, to the position of special agent in charge of the Porto Rico Experiment Station. Mr. Gardner's preliminary investigations began in May and continued throughout June and July. During the last three weeks in June and the first three weeks in July he was assisted by O. F. Cook and G. N. Collins, of the Bureau of Plant Industry of this Department.

INCOME.

The appropriation for the investigations in Porto Rico for the past fiscal year was $5,000, and for the current fiscal year is $12,000.

PUBLICATIONS.

A report on a portion of the work of the past year was published as House Document No. 171 (Fifty-sixth Congress, second session). A second report has been prepared and is submitted herewith (pp. 381–415).

GENERAL OUTLOOK.

The appropriation for the current year provides for the establishment and maintenance of an agricultural experiment station in Porto Rico. In accordance with this provision, steps have been taken for the establishment of such a station. As the appropriation available this year is not sufficient for the purchase of a tract of land suitable for the permanent location of the station, it was decided to start some experimental work on a temporary basis.

For this temporary work 30 acres of land adjacent to the town of Rio Piedras has been leased, together with a large frame house, which serves as a residence and office for the special agent and also furnishes accommodations for laboratories and a library. In addition to this the local normal school has donated temporarily the use of 40 acres of land for experimental purposes. The necessary horses, mules, and oxen have been secured and a stable constructed for their shelter. A farm wagon, an ox cart, several plows and harrows, together with garden and horticultural tools, have been secured, and a piece of land has been cleared of weeds, banana stumps, etc., and plowed. Bulbs, tubers, and quite a variety of vegetables have been planted, and a large number of vegetable seeds have been distributed to farmers. Cooperative work was commenced October 1, 1901, on a coffee plantation, with the object of improving methods of growing coffee in Porto Rico. Investigations have been started also to discover means for combating certain troublesome insects and fungus and bacterial diseases of plants.

The station has arranged to cooperate with the Bureau of Soils of this Department in making a soil survey of a portion of the island, beginning January 1, 1902. The organization of a regular station staff has been begun, the force now including the special agent in charge, the entomologist and botanist, and the farm foreman.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, *Kingston.*

Department of Rhode Island College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Managers: Henry L. Greene (*Pres.*), *River Point;* Jesse V. B. Watson (*V. Pres.*), *Wakefield;* C. H. Coggeshall (*Clerk*), *Bristol;* Melville Bull (*Treas.*), *Newport;* Benj. A. Jackson, *Providence.*

STATION STAFF.

John H. Washburn, Ph. D., *President of the College.*

H. J. Wheeler, Ph. D., *Dir.; Chem.*
Fred W. Card, M. S., *Hort.*
Cooper Curtice, D. V. S., M. D., *Biol.; Poultryman.*
Burt L. Hartwell,[a] M. S., *Asst. Chem.*
Jas. W. Kellogg, B. S., *Asst. Chem.*
George E. Adams, B. S., *Asst. Field Expt.*
Alfred W. Bosworth, B. S., *Asst. Chem.*
L. P. Sprague, *Asst. Hort.*
Nathaniel Helme, *Met.*
S. Aline Nye, *Sten.*
Mary G. Schermerhorn, *Sten.*

[a] On leave.

LINES OF WORK.

As in previous years, the work of the Rhode Island Station during the past year has included plat and pot experiments with lime, sodium fertilizers, and rotations, and on the availability of fertilizer ingredients in soils and manures as affected by lime, magnesia, etc., with related chemical investigations; experiments with varieties, methods of planting, fertilizing, interpollination, etc., of bush fruits; experiments with small fruits, especially with strawberries and red raspberries, with a view to securing varieties suited to the locality; and poultry experiments, including breeding and feeding experiments with hens, geese, and pigeons, studies of poultry diseases, experiments in determining the best feeds and most favorable conditions for rearing incubator chicks and producing broilers, and studies to find a practical means of eradicating the blackhead disease from Rhode Island, so as to render possible the successful prosecution of the turkey industry. Breeding experiments with Belgian hares have been continued, as have also the tests of varieties of various seeds and plants in cooperation with this Department. The fertilizer and feeding stuffs inspection has been continued by the chemist and his assistants with State funds. September 1, 1901, the director of the station resigned and the chemist, H. J. Wheeler, was appointed to succeed him.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	568.45
Miscellaneous, including balance from previous year	208.96
Total	15,777.41

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–76 and the Annual Reports for 1899 and 1900.

Bulletin 66, pp. 14, pls. 7, dgm. 1.—Effect of Lime upon Grasses and Weeds.—Details and results of plat experiments extending over a number of years in which a study was made of the effect upon the relative yields and durability of grass and weeds of lime applied in connection with potash and phosphoric acid and different amounts of nitrate of soda, sulphate of ammonia, and dried blood.

Bulletin 67, pp. 8.—Commercial Fertilizers.—Analyses and valuations of 14 samples of fertilizers with explanatory notes.

Bulletin 68, pp. 18.—Treatment of the Sandy Soils of Rhode Island.—

A discussion of the needs and treatment of the Warwick Plain and other sandy soils of Rhode Island with the results of several plat and plain experiments.

Bulletin 69, pp. 30, pls. 3.—A Study of Plant Adaptations.—Observations upon the growth of a large number of different kinds of plants on an acid upland soil, limed and unlimed.

Bulletin 70, pp. 12.—Analyses of Commercial Fertilizers.—Analyses and valuations of 55 samples of fertilizers.

Bulletin 71, pp. 8.—Experiment in Top-dressing Grass Land.—Results for 1900 of experiments in applying no nitrogen and 150 and 450 pounds of nitrate of soda per acre to grass lands.

Bulletin 72, pp. 16, pls. 9.—Special Instruction in Poultry Culture.—The special course of instruction on the care and management of poultry which the station offers is described.

Bulletin 73, pp. 14.—Commercial Fertilizers.—Tabulated analyses of 73 samples of fertilizing materials not previously reported, with a summary of the results of fertilizer inspection.

Bulletin 74, pp. 24.—A Rotation of Crops.—An account of a rotation experiment with potatoes, rye, and clover, with a discussion of the advantages of crop rotations and a detailed history of the plats used in the experiment.

Bulletin 75, pp. 28.—A Four-year Rotation of Crops.—A detailed description of the conditions of a rotation experiment with corn, potatoes, rye, and clover, with the results obtained.

Bulletin 76, pp. 26.—A Five-year Rotation of Crops.—Detailed results for the first year of a rotation experiment with corn, potatoes, and rye one year each, and grass two years.

Annual Report, 1899, pp. 139, pls. 2.—This includes a report of the director giving a general review of the work of the station during the year; a financial statement for the fiscal year ended June 30, 1899; lists of donations, exchanges, and station publications; and departmental reports containing in addition to summaries of the different lines of work results of several experiments with orchard fruits and lettuce, an account of experiments with carnations for the prevention of stem rot, miscellaneous chemical analyses, studies of the amount of humus in soils and the percentage of nitrogen in the humus as affected by applications of air-slaked lime and certain other substances, a brief account of four cooperative experiments with grasses in continuation of earlier investigations on the lime requirements of Rhode Island soils, observations upon the after effect of sulphur when applied to soils for the purpose of preventing potato scab, results of a comparative trial of different clover and grass mixtures for seeding, results of experiments in liming grass lands before and after seeding, observations upon the effectiveness of nitrate of potash as compared with like amounts of nitrogen and potash in form of muriate of potash and nitrate of soda,

a popular discussion of poultry breeding, and meteorological observations.

Annual Report, 1900, pp. 191, pls. 10.—This includes the organization list of the station; a report of the director reviewing the work of the station during the year and giving notes on the annual meeting of the Association of American Agricultural Colleges and Experiment Stations; a list of station publications during the year and notes on the station staff; departmental reports reviewing in detail the different lines of station work and containing results of investigations concerning the life history and transmission of the organism producing roup, observations on the apple maggot and the stem rot of carnations, notes on the treatment of an old apple orchard, a study of the frost resistance of three varieties of bush beans, results of experiments in forcing lettuce and rhubarb, an account of work in the crossing and selection of strawberries, a popular article on horticulture from an educational standpoint, miscellaneous chemical analyses, a summary of results of pot and plat experiments on the acidity of upland soils begun in 1894, a popular discussion of heredity with special reference to poultry, meteorological observations; a financial statemement for the fiscal year ended June 30, 1900; and list of donations, exchanges, and of the publications of the station since its organization.

GENERAL OUTLOOK.

Rhode Island is peculiarly adapted to intensive farming. Old worn-out areas should be rejuvenated and new industries adapted to local conditions must be developed; hence the importance of investigating problems related to the improvement of the soil, and the development of the poultry and fruit industries. The station officials are giving much attention to rotation and fertilizer experiments, especially the application of lime to acid soils and of top-dressing to old grass lands, supplementing plat experiments by pot experiments; to the rejuvenation of old apple orchards and problems affecting the production of small fruits and garden truck and to poultry production. An effort will be made to discover the most wholesome feeds for incubator chicks, causes of mortality in incubator chicks, and means for combating troublesome poultry diseases. The poultry plant has been removed to a new and more suitable location, and reduced in size, but improved in condition.

Station officers attend farmers' institutes to a limited extent, cooperate with the college in conducting correspondence and nature study courses, and do a considerable amount of teaching in the college. Cooperative experiments with crops are carried on with farmers in different parts of the State with decided success. A greenhouse suitable for horticultural investigations is needed. The station is under efficient management and apparently has before it a career of increased usefulness to the agricultural interests of the State.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College.*[a]

Department of Clemson Agricultural College.

GOVERNING BOARD.

STATION STAFF.

Henry S. Hartzog, LL. D., *President of the College and Director.*

J. S. Newman, *V. Dir.; Agr.*
M. B. Hardin, *Chem.*
B. F. Robertson, B. S., *Asst. Chem.*
F. S. Shiver, Ph. G., *Asst. Chem.*
D. H. Henry, B. S., *Asst. Chem.*
C. M. Conner, B. Agr., B. S., *Asst. Agr. and Dairyman.*
C. C. McDonnell, *Asst. Chem.*
R. N. Brackett, Ph. D., *Asst. Chem.*
C. C. Newman, *Hort.*
Chas. E. Chambliss, *Ent., Bot., and Bact.*
G. E. Nesom, B. S., D. V. M., *Vet.*
C. O. Upton, *Dairyman.*
J. S. Pickett, *Station Foreman.*

J. N. Hook, *Sec.*

LINES OF WORK.

The work of the South Carolina Station during the past year has included variety, cultural, and fertilizer experiments with wheat, cotton, and forage crops; cultural and fertilizer experiments with oats, peas, sweet potatoes, tobacco, chufas, artichokes, melons, and other miscellaneous crops; pasturage and other experiments with breeds of swine for economic pork production; experiments with poultry for egg and meat production; experiments with Carolina rice meal as a feed for milch cows and for young pigs; investigation of the chemical composition of the rice plant and its products; analysis of fertilizers, drinking water, minerals, ores, and soils; entomological investigations, especially with the chinch bug, parasites of poultry, and insects injurious to the cotton plant, peanut, pecan, and the grapevine; diseases of animals, especially Texas fever, glanders, and milk fever. For cows having milk fever the veterinarian has devised a modification of the apparatus for giving the Schmidt treatment, which it is claimed is very effective in reducing the number of deaths. Other work includes the investigation of plant diseases, including cotton-boll rot, potato rot, rusts, smuts, blights, black knot, peach yellows, etc.; plant breeding experiments with varieties of peaches and oranges; experiments with spraying solutions for peach trees and grapevines; growing ginseng; fertilizer and variety experiments with potatoes and garden vegetables; and forcing-house tests with lettuce, cucumbers, tomatoes, strawberries, and cauliflower.

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[a] Telegraph office, *Clemson College*, express and freight address, *Calhoun.*

During the year the station has been given funds for improving to a considerable extent its equipment, the most notable improvements being new equipment for soil physics and for evaporating sweet potatoes, a new poultry house for incubators and brooders, and a large addition to the chemical laboratory. The laboratory of the station botanist has been separated from that used by students; a more complete separation of station land and live stock from that used by the other departments of the college has been made; a cottage has been built for the station foreman; and other changes have been made which will facilitate the experimental work of the station. Members of the staff take part in farmers' institutes, which are growing in favor, the college institute especially having an attendance of nearly 500 farmers from all parts of the State. During the year the botanist resigned to accept a position in this Department, and the vacancy caused by the resignation of the entomologist was filled by the appointment of Charles E. Chambliss.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	783.26
Total	15,783.26

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 54–63.

Bulletin 54, pp. 13.—Analysis of Commercial Fertilizers.—Tabulated analyses and valuations of 154 samples of fertilizers.

Bulletin 55, pp. 7.—Feeding Rice Meal to Pigs.—A comparison with 6 pigs of feeding corn meal and rice meal supplemented by skim milk.

Bulletin 56, pp. 12.—Wheat.—Results of variety, seeding, fertilizer, and culture experiments with wheat during 1900.

Bulletin 57, pp. 16.—Fungicides.—A general discussion covering the preparation and use of fungicides.

Bulletin 58, pp. 27, pls. 14, figs. 5.—Grapes.—A popular bulletin on grape culture, including the laying out of the vineyard, planting, cultivation, pruning, training, trellises, spraying, selection of varieties, etc.

Bulletin 59, pp. 16.—A Chemical Investigation of the Rice Plant

and of the Product and By-products of the Rice Industry.—Notes on the history and production of rice, a brief description of the processes employed in milling or cleaning the grains, and tabulated analyses of 21 samples, comprising parts of the rice plant and various by-products.

Bulletin 60, pp. 24.—Analysis of Commercial Fertilizers.—Analyses of 186 samples of fertilizing materials, with a discussion of the composition and valuation of fertilizers and the laws and regulations governing the sale of commercial fertilizers in South Carolina.

Bulletin 61, pp. 12, pls. 3.—Corn.—Culture, fertilizer, and variety tests with corn are reported in tabular form and briefly discussed.

Bulletin 62, pp. 11, pls. 2.—Capons and Caponizing.—Brief notes are given on the value of capons and the method of caponizing is described.

Bulletin 63, pp. 37.—Sweet Potato.—Experiments to determine the effect of fertilizing with different forms of potash upon the starch content of the sweet potato, the effect of storing upon the composition of sweet potatoes, and the relative value of several methods of storing in general use are reported.

GENERAL OUTLOOK.

The station is striving with considerable success for the development of greater diversity in agricultural production, especially along the lines of dairying, fruit growing, and market gardening, and for the instruction of the farming population by means of farmers' institutes. During the year marked progress has been made in the separation of the station equipment from that of other departments of the college, and the management of the station has been put on a more independent basis. According to by-laws of the board of trustees published in 1900, the direct management of the station is now committed to the vice-director, the president of the college exercising only general supervision, and the board of trustees having nothing to do with the details of the work. On the whole, the conditions at this station are greatly improved and there is promise of still more effective work in the near future.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, *Brookings.*

Department of South Dakota Agricultural College.

GOVERNING BOARD.

Regents of Education: Frederick A. Spafford (*Pres.*), *Flandreau;* I. D. Aldrich (*Sec.*), *Bigstone;* I. W. Goodner, *Pierre;* M. F. Greeley, *Gary;* L. M. Hough, *Sturgis;* R. M. Slocum, *Mound City.*; R. A. Larson (*Sec. and Accountant*).

STATION STAFF.

John W. Heston, M. A., Ph. D., LL. D., *President of the College and Acting Director.*
E. C. Chilcott, M. S., *V. Dir.; Agr.*
Jas. H. Shepard, B. S., *Chem.*
De Alton Saunders, M. A., *Bot.*
E. L. Moore, B. S., D. V. S., *Animal Path.*
N. E. Hansen, M. S., *Hort.*
W. S. Thornber, *Asst. Hort.*
A. B. Holm, B. S., *Asst. in Soils.*
A. H. Wheaton, *Asst. in Dairying.*
R. F. Kerr, *Libr.*
R. A. Larson, *Accountant.*
Frank G. Orr, *Sec.*

LINES OF WORK.

The work of the South Dakota Station during the past year has proceeded along the same general lines as noted in previous reports, attention being given to the analysis of soils, forage plants, and grain; studies of diseases of plants and animals; experiments in testing varieties and breeding vegetables, cereals, and fruits; tree planting; digestion experiments, and studies of the effect of farm manure and methods of tillage on soil moisture and the physical condition of soils. The department of chemistry has completed the work in soil analysis and prepared the results for publication. The veterinarian is studying diseases of sheep and swine, and the assistant in dairying is doing some work in testing milk. A State veterinarian appointed July 1, 1901, will cooperate with the station veterinarian in studying anthrax.

The station is cooperating with the Bureau of Forestry of this Department in tree planting and with the Bureau of Plant Industry in experiments for renewing worn-out pasture lands. The latter experiments are being conducted at Highmore, where about 20 acres are devoted to the purpose, besides about 50 acres devoted to tests of forage crops. The station has also tested a large number of varieties of wheat, barley, spelt, and other plants sent out by this Department. Macaroni wheats have made a good showing. In the horticultural department breeding experiments are being conducted on a very extensive scale. Many thousand seedlings of native fruits are being raised for the purpose of originating new varieties suited to the climate, and hardy stocks of various kinds are being tried. An effort is being made to improve the stubble berry or nightshade (*Solanum nigrum*) as found upon the prairies of the State. The fruit of this plant is much used by the prairie settlers for canning and for making pies and preserves. The need of a hardy race of strawberries has led the station to begin crossing the wild strawberries of the Dakotas and Manitoba with cultivated sorts. Breeding experiments are being conducted also with hazelnuts, wild grapes, and buffalo berries. The legislature at its last session appropriated $40,000 for an engineering and physics building for the college and $10,000 for a building to be devoted to plant breeding. The latter will directly benefit the station. At the beginning of the present fiscal year the director was removed and the president of the college was made acting director of the station.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,000.00
Farm products	817.74
Miscellaneous	500.00
Total	17,317.74

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–69 and the Annual Reports for 1899 and 1900.

Bulletin 66, pp. 20.—Drought-resisting Forage Plants at the Cooperative Range Experiment Station, Highmore, S. Dak.—Results of tests for one year of different forage plants, with mechanical and chemical analyses of the soils of Highmore.

Bulletin 67, pp. 50, pls. 7.—Watermelons and Muskmelons in South Dakota.—Results are here reported in tables and descriptive notes of tests of a large number of varieties of foreign and American watermelons and muskmelons during the years 1898 and 1899.

Bulletin 68, pp. 56, pls. 11.—Vegetables in South Dakota.—Results of tests of a large number of varieties of vegetables and of culture experiments, including subsoiling and starting plants in a cold frame as compared with starting in a greenhouse.

Bulletin 69, pp. 54, pls. 3, figs. 9.—Native and Introduced Forage Plants.—Descriptions, notes on distribution, and chemical analyses of over 40 grasses and forage plants.

Annual Report, 1899, pp. 8.—Brief abstracts of Bulletins 61–64 of the station, and a financial statement for the fiscal year ended June 30, 1899.

Annual Report, 1900, pp. 34.—A general account of the work of the station during the year is given in the reports of the director, agriculturist, horticulturist, chemist, entomologist and botanist, and the zoologist and veterinarian. A financial statement for the fiscal year ended June 30, 1900, is included.

GENERAL OUTLOOK.

The South Dakota Station continues to direct much of its effort to the introduction and development of hardy and drought-resistant varieties of agricultural and horticultural plants, and to this end is testing introduced varieties from high latitudes in Europe, growing native and seedling varieties, and crossing native on introduced plants. The

divisions of agriculture, botany, and horticulture are cooperating in this work and their efforts give promise of valuable results. Difficulties in the administration of this station have of late been a hindrance to its work. There is still need of a settled policy of management by which the work of the station will be clearly differentiated from that of other departments of the college. The station should again have a separate director, who should be made fully responsible for its work and expenditures, and be given authority to control the funds of the station and the work of members of the staff in accordance with a well matured plan of investigations.

TENNESSEE.

Tennessee Agricultural Experiment Station, *Knoxville.*

Department of the University of Tennessee.

GOVERNING BOARD.

STATION STAFF.

Chas. W. Dabney, Ph. D., LL. D., *President of the College.*

Andrew M. Soule, B. S. A., *V. Dir. and Agr.*
Charles A. Keffer, B. H., *Hort. and For.*
C. A. Mooers, B. S., *Chem.*
S. M. Bain, B. A., *Bot.*
Weston M. Fulton, *Met.*
John R. Fain, *Farm Manager.*
Phares O. Vanatter, *Plat Expert.*
Samuel E. Barnes, B. S., M. S. A., *Dairyman.*
M. Jacob, V. M. D., *Vet.*
Ethel Reese, *Sten.*

F. H. Broome, *Libr.*

LINES OF WORK.

The work of the Tennessee Station during the past year has been continued along the same general lines as formerly, and has included plat and field experiments with clovers and other legumes for forage and green manuring and with wheat and grasses; dairying; feeding experiments with dairy and beef cattle and hogs; horticultural investigations, including orchard work, spraying, and variety tests of strawberries; study of the effect of fungicides on foliage; chemical study of soils, combined with cooperative field experiments in various parts of the State, and meteorological observations. The station is cooperating with the Bureau of Plant Industry of this Department in investigations of the influence of origin of red-clover seed on the yield of crop and experiments in the formation and management of meadows and pastures.

Early in the year the agriculturist was made vice-director and placed in charge of the station work. A farm foreman was employed

so that the farm manager might have more time for experimental work in animal husbandry, and other changes were made, all of which places the staff on a better basis for specialization along lines of research. A change in policy with regard to the dairy herd was made, the idea being to secure a herd of pure-bred Jerseys, and 10 animals were purchased. The investigation of the growth of young apple trees has been continued. In the agricultural department the equipment has been considerably improved, and in the meteorological department an automatic electrical recording river gauge has been perfected. The library received a donation of over 150 books from the president of the university. The station has begun issuing frequent press bulletins, which are quite generally used by the newspapers of the State. Farmers' institutes are attended by members of the staff.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	3,709.11
Total	18,709.11

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins Vol. 13, Nos. 2–4, and Vol. 14, No. 1, and the Annual Report for 1900.

Bulletin Vol. 13, No. 2, pp. 24, pl. 1, figs. 5.—Experiments with Winter Wheat.—Experiments with wheat, including fertilizer and variety tests, intertillage experiments, and trials of different rates of seeding, and seed selection are reported in detail and the results are discussed at some length.

Bulletin Vol. 13, No. 3, pp. 23, pl. 1, fig. 1.—Fertilizer Experiments during 1900.—The experiments reported in this bulletin consist of tests of fertilizers for potatoes, corn, cowpeas, and peanuts, and the effects of fertilizer applications on the germination of the seeds of these crops. The results are given in tabular form and discussed.

Bulletin Vol. 13, No. 4, pp. 23, figs. 8.—Feeding Native Steers.—An account of tests with 8 steers of the comparative value of cotton-seed meal and cowpea vine hay as sources of protein and the feeding value of finely ground cotton-seed hulls or cotton-seed bran, with a summary of the results obtained.

Bulletin Vol. 14, No. 1, pp. 31, pl. 1, figs. 11.—Experiments with Corn, Forage Crops, and Spring Cereals.—This bulletin reports the results of tests of varieties of corn, sorghum, Kafir corn, durra, broom corn, cowpeas, millet, Canadian field peas, and spring varieties of wheat, oats, and barley; and of tests of sowing rape, oats, and barley at different dates, and of seed corn taken from different parts of the ear. The draft these crops make on the soil and the root systems of corn, sorghum, cowpeas, and soy beans were also studied.

Annual Report, 1900, pp. 40, pls. 2, figs. 11, charts 3.—This includes a general outline of station work during the year; a history of the station from 1882 to 1900, with a list of publications issued during that time; reports by the agriculturist, botanist, horticulturist, chemist, and librarian reviewing the work of the different departments; a brief discussion of the object, construction, and use of daily weather charts by the meteorologist, and a financial statement for the fiscal year ended June 30, 1900.

GENERAL OUTLOOK.

The Tennessee Station is conducting a number of lines of work of great importance to the agriculture of the State. Its efforts to introduce improved varieties of winter cereals are important because the culture of such crops keeps the ground covered, prevents losses of nitrogen and the washing of soil, and enables the production of large quantities of grain for feeding live stock. Of closely related importance are the establishment of good pastures and meadows, and the production of legumes for silage and for green forage. The station has demonstrated that wheat, barley, and oats can be profitably grown in Tennessee, and that they can be removed in time to sow cowpeas, sorghum, corn, etc., for silage or winter feeding. The exhausted condition of many of the soils of the State gives importance to studies relating to the rotation of crops and the restoration of fertility by means of natural and artificial fertilizers and green manuring crops. By the use of green manures alone the station has shown that some of the poorest and most neglected soils of the State can be reclaimed. Other important work has been the chemical examination of the cotton plant, the utilization of cotton-seed meal in feeding beef and dairy cattle, the successful spraying of fruit trees for fungus diseases and injurious insects, and the preparation of a soil map of the State.

The dissemination of information regarding these investigations through the station publications, the newspapers of the State, attendance of the staff upon farmers' institutes and meetings of farmers at the university has brought the farmers in touch with the station and widened its sphere of influence. These conditions and the organization of the staff on a more efficient basis put the station in a position to be of great usefulness to the agriculture of the State.

TEXAS.

Texas Agricultural Experiment Station, *College Station.*[a]

Department of the State Agricultural and Mechanical College of Texas.

GOVERNING BOARD.

Board of Directors: M. Sansom (*Pres.*), *Alvarado;* F. A. Reichardt, *Houston;* A. C. Oliver, *Douglassville;* William Malone, *Hunter;* P. H. Tobin, *Denison;* A. P. Smyth, *Mart;* John W. Kokernot, *San Antonio;* Jeff Johnson, *Austin.*

STATION STAFF.

R. H. Whitlock, M. E., *President pro tem. of the College.*

J. H. Connell, M. S., *Dir.*
H. H. Harrington, M. S., *Chem.*
M. Francis, D. V. M., *Vet.*
R. H. Price, B. S., *Hort.*
B. C. Pittuck, B. S. A., *Agr.*
P. S. Tilson, B. S., *Asst. Chem.*
E. A. White, *Asst. Hort.*
J. W. Walden, B. S., *Student Asst. in Hort.*
K. K. Hooper, *Chief Clerk.*
J. G. Harrison, *Bookkeeper.*
J. J. Hooper, *Sten. and Clerk.*
S. A. McHenry, *Supt. State Sta.* (*Beeville*).

J. W. Carson, B. S. A., *Supt. of Farm.*

LINES OF WORK.

The principal lines of work undertaken at the Texas Station during the past year, named in the order of the effort and money expended in their support, are as follows: Experiments with grasses, forage plants, corn, cotton, and fertilizers in cooperation with more than 100 farmers throughout the State; investigation of the Texas fever problem, especially methods of treatment after inoculation to reduce the fatality resulting from inoculation; experiments with orchard fruits, dewberries, blackberries, strawberries, and figs; investigations in making molasses from sugar cane for the purpose of increasing the value of this crop when grown upon farms not convenient to sugarhouses. The station is cooperating with this Department as follows: With this Office in irrigation investigations; with the Bureau of Plant Industry in efforts to improve the wheat industry and in experiments at selected points to test the adaptability of certain forage plants for meadows and pastures; with the Bureau of Forestry in tree planting; with the Bureau of Chemistry in studying the influence of environment on the sugar content of muskmelons; with the Bureau of Soils in the selection of typical soil areas, and with the Division of Entomology in studies of the Mexican cotton-boll weevil.

The completion of the new agricultural and horticultural building and the purchase of valuable equipment have materially improved the facilities for station work. In this building a cannery is being equipped, partly for experimental purposes. During the session of the legislature held the past summer liberal appropriations for both college and station were made. Five thousand dollars was added to

[a] Express and telegraph address, *Bryan.*

the general maintenance fund; $3,100 was appropriated for building and equipping a chemical and veterinary laboratory for college and station; $1,500 was added to the State entomologist's appropriation; the appropriation for the Beeville substation was increased from $5,000 to $7,500 (for two years); and $5,000 per annum was voted for the establishment and maintenance of a new substation.

The work of the Beeville substation has consisted of variety tests with fruit, general orchard, and vineyard work, together with extensive variety, cultural, and fertilizer experiments with watermelons, cantaloupes, and onions. The work is supervised by the agriculturist of the station and is in charge of a resident superintendent.

INCOME.

The income of the station for the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	2,500.00
Miscellaneous, including balance from previous year	691.47
Total	18,191.47

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 57 and 58.

Bulletin 57, pp. 24, pls. 10.—Cabbage.—Fertilizers, Varieties, Shipping; Cauliflower.—Varieties and Shipping.—General directions for growing and marketing cabbage and cauliflower, including a financial statement of the sale of a carload of cabbage shipped by the station to Kansas City and an estimate of the cost of growing an acre of cabbage; and detailed data for rather extensive fertilizer and variety tests.

Bulletin 58, pp. 18, figs. 15.—Pruning and Training Peach Orchards.—This subject is discussed at some length, proper and faulty methods of pruning the peach being illustrated and results from other stations relative to the Stringfellow method of root pruning being quoted.

GENERAL OUTLOOK.

During the year a relatively large amount of attention has been given to the extension of cooperative experiments with farmers, which have been found potent means for improving agricultural practice, in developing new industries, and bringing the farmers into sympathy with the work of the station. Much attention is also given to unsolved

problems in the investigations on Texas fever and to the development of horticultural interests, especially truck farming in the southern part of the State. The college and station have succeeded in enlisting the cordial support of farmers, stockmen, and horticulturists. In July of this year the annual session of the Texas Farmers' Congress, of which Director Connell is president, was held at the college. It was attended by about 450 delegates, representing the following 12 associations: State Horticultural Society, Texas Jersey Cattle Club, Texas Dairymen's Association, Texas Cotton Growers' Association, Texas Live Stock Association, Texas Truck Growers' Association, Texas Floral Association, South Texas Truck and Fruit Growers' Association, Central Texas Beekeepers' Association, Texas Poultry, Pigeon, and Pet Stock Association, Texas Nurserymen's Association, and the Women's Industrial Section. Resolutions were adopted indorsing the work of the station, favoring the establishment of more substations, and urging the organization of farmers' institutes in all parts of the State. In this and other ways it is evident that the work of the station is making a strong impression on the farmers of the State, and, with its improved facilities and enlarged resources, the outlook for its greater usefulness is very promising.

UTAH.

Agricultural Experiment Station, *Logan.*

Department of the Agricultural College of Utah.

GOVERNING BOARD.

Board of Trustees: W. S. McCormick (*Pres.*), *Salt Lake City;* P. W. Maughan (*Sec.*), *Logan;* Allan M. Fleming (*Treas.*), *Logan;* Mrs. Emily S. Richards, *Salt Lake City;* D. C. Adams, *Salt Lake City;* John A. McAlister, *Logan;* L. Hansen, *Wellsville;* Mrs. R. N. Bagley, *Ogden;* Seth A. Langton, *Logan.*

STATION STAFF.

W. J. Kerr, D. Sc., *President of the College.*

J. A. Widtsoe, Ph. D., *Dir.; Chem.*
F. B. Linfield, B. S. A., *Animal Indus.*
G. L. Swendsen, C. E., *Hydraulic Engin.*
Ephraim G. Gowans, M. D., *Biol.*
James Dryden, *Met. and Poultry Manager.*
Lewis A. Merrill, B. S., *Agron.*
W. W. McLaughlin, *Asst. Chem.*
J. A. Wright, *Hort.*
P. A. Yoder, Ph. D., *Asst. Chem.*
Charles Batt, *Foreman Hort. Grounds.*
John A. Crockett, *Asst. Dairyman.*
Allan M. Fleming, *Treas.*
Peter W. Maughan, *Sec.*
J. B. Nelson, *Foreman of Farm.*

LINES OF WORK.

The work of the Utah Station during the past year continued to adhere closely to irrigation. The principal subjects of investigation were the duty of water for garden vegetables, small fruits, and the orchard; measurement and division of water; the laws of the flow of

water, seepage, evaporation, and methods of irrigation; survey of actual irrigation conditions; dry farming; experiments with wheat, oats, and barley to develop varieties with drought-resisting properties; grasses and forage crops for the arid West; curing and handling alfalfa; destruction of dodder; rotation of crops; plants for alkali lands; feeding value of crops grown with different amounts of water; pasture *v.* soiling on irrigated lands; the value of alfalfa fed with other fodders; dairy by-products in feeding hogs and calves; feeding experiments with sheep and dairy cows; alfalfa *v.* timothy for horses; influence of alfalfa on the color and flavor of butter; testing varieties of fruit trees; experiments to originate red winter apples; keeping qualities of apples; spraying experiments; effects of thinning peaches and ringing grapevines; silk culture; forcing-house tests with tomatoes, lettuce, rhubarb, mushrooms, winter muskmelons, and watermelons; chemical investigations, including the effect of irrigation on the composition of plants, digestibility of plants grown with different amounts of water, irrigation *v.* soil fertility, alkali lands and their reclamation, irrigation waters, soil survey of Utah, and soil moisture in irrigation work; poultry experiments, including breeding experiments to develop good layers, feeding experiments, methods of feeding and management, relative profitableness of different breeds, pullets *v.* hens for layers, artificial incubation, and value of caponizing. Irrigation investigations in cooperation with this Office have been continued. Cooperative work has also been arranged with several bureaus of this Department, and includes sugar-beet investigations with the Bureau of Chemistry, tree planting with the Bureau of Forestry, experiments with grasses and forage plants for arid and alkali soils with the Bureau of Plant Industry, and investigations of alkali soils with reference to seepage and drainage with the Bureau of Soils.

The State legislature at its last session was quite liberal to the college and station, giving them about $108,000. Of this amount $10,000 has been expended in the construction of a cattle barn and a sheep barn and in the remodeling of the old barn; $3,800 has been set aside for use in purchasing pure-bred stock; $1,550 for hog pens, yards, fences, floors, etc.; $1,500 for a vegetation house; $1,000 for purchasing land on the plains for experimental purposes, and $250 for a water right. All of these expenditures will be mainly for the benefit of the experiment station, which will thus be well equipped, especially for work in animal husbandry and irrigation. Owing to the diseased condition of the old herds, all live stock, with the exception of horses, has been disposed of and only new, sound animals will be put in the new barns. The legislature also appropriated $6,000 for two years for a fruit experiment station at St. George, to be known as the Southern Utah Experiment Station. The college expended during the year $1,500 in promoting the farmers' institute movement, station

officers doing most of the work. During the year the horticulturist, C. P. Close, resigned to accept a similar position at the Delaware College and Station.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	4,054.08
Balance from previous year	727.77
Total	19,781.85

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–71 and the Annual Report for 1900.

Bulletin 66, pp. 10, pls. 2.—Corn Experiments.—Results of tests of 17 varieties of corn during periods of 5 to 10 years are given, with notes on leading varieties; and tests of the relative value of deep and shallow tillage, of hilling and level tillage, and of thick and thin planting are reported in full and results secured at other stations in tests of hill *v.* drill culture of corn are discussed.

Bulletin 67, pp. 42, pls. 6.—Poultry Experiments.—Experiments here reported in detail and summarized included tests of the relative value of pullets and hens and of early and late hatched pullets; the effect of exercise on egg production; the feeding value of corn, dried blood, and sunflower seed; and of the value of caponizing.

Bulletin 68, pp. 148, figs. 7, dgms. 9.—Experiments with Dairy Cows.—Part I of this bulletin contains records of the station dairy here for 5 years, results of studies of the influence of the weight of the cow, period of lactation, dehorning, methods of feeding, type, and change of milkers upon the yield and quality of milk and the economy of production, and data showing the variations in the different constituents of the milk of a number of cows, with a discussion of methods of testing cows and sampling milk at creameries. Part II gives an account of feeding tests with milch cows made each winter for 4 years to compare alfalfa alone with alfalfa and corn fodder. Part III gives the results of summer feeding experiments for 4 years in soiling and pasturing to compare the results obtained from 1 acre of land when the crop was pastured and when it was soiled, to study the effect of feeding grain to cows on pasture, and to test the relative effects of soiling and pasturing on alfalfa and mixed grasses. The bulletin also

contains notes on the management of cows on pasture in relation to bloat, and a general summary.

Bulletin 69, pp. 30.—The Golden Vine Field Pea.—Results of investigations of the chemical composition of the whole plant, leaves, stalks, and flowers of the Golden Vine field pea at different stages of growth; data on the yield per acre; results of artificial digestion experiments with the whole plant and different parts; and discussions of the food value of this plant and related topics.

Bulletin 70, pp. 70, pls. 4.—Experiments in Pork Production.—Tests covering several years are reported of summer feeding of pigs in which the value of mixed pasturage, alfalfa pasturage, and the effects of exercise were the principal questions studied and of winter feeding, in which a special study was made of the value of roots and alfalfa. Tests of the feeding value of rape and of the comparative value of barrows *v.* sows and of spayed *v.* unspayed sows are also reported, and several general questions bearing on the investigations are discussed, including the effects of feeding balanced rations, wet and dry grains, skim milk and grain, and whole milk and grain.

Bulletin 71, pp. 56, figs. 42.—Carrying Capacities of Irrigation Canals.—This is a report of 64 experiments made during the summer of 1897 on irrigation channels varying in size from small ditches carrying a few miners' inches to large canals carrying as high as 225 second-feet, and including nearly every form of ditch common to Western America. Objects sought were to ascertain the existing condition of ditches and canals which had been in operation for a number of years, to determine the values of the coefficient of roughness under different conditions, and to ascertain the form which channels assume when acted upon by water and the atmosphere.

Annual Report, 1900, pp. 76, pls. 10.—This contains a report of the director reviewing at some length the history, organization, equipment, work, and publications of the station; a subject list of Bulletins 1–70 of the station; a financial statement for the fiscal year ended June 30, 1900; list of exchanges; and departmental reports giving outlines of investigations in horticulture, irrigation, poultry raising, chemistry, dairying, and stock feeding, together with meteorological observations and some of the results of work along different lines, including forcing and irrigating vegetables and feeding experiments with steers and sheep.

GENERAL OUTLOOK.

The administratiion that took charge of the station September 1, 1900, found that experiments which had been in progress for many years had been completed, and hence devoted much necessary time to the work of perfecting plans for new experiments and inaugurating some of them. Irrigation was wisely chosen as the central subject of

investigation. For example, the work in animal husbandry will be confined mainly to a study of the most profitable utilization of irrigated crops. Studies of orchard and garden irrigation will be made and the new vegetation house will be devoted largely to studies in irrigation. The piece of valley land purchased is more typical of the larger portion of the farming lands of Utah than that of the present station farm, and will therefore be a valuable acquisition to the station. The departments of agronomy, animal husbandry, and irrigation engineering are cooperating closely in a study of animal and plant production under conditions of irrigated agriculture. The work begun seems to be well planned and is being energetically prosecuted.

VERMONT.

Vermont Agricultural Experiment Station, *Burlington.*

Department of University of Vermont and State Agricultural College.

GOVERNING BOARD.

Board of Trustees—Board of Control: Matthew Henry Buckham (*Pres.*), *Burlington;* E. J. Ormsbee, *Brandon;* G. S. Fassett, *Enosburg;* Cassius Peck, *Burlington.*

STATION STAFF.

Matthew Henry Buckham, D. D., LL. D., *President of the University*

J. L. Hills, B. S., *Dir.*
G. H. Perkins, PH. D., *Ent.*
L. R. Jones, PH. B., *Bot.*
F. A. Waugh, M. S., *Hort.*
F. A. Rich, V. S., M. D., *Vet.*
Cassius Peck, *Supt. Farm.*
C. H. Jones, B. S., *Chem.*
B. O. White, PH. B., *Asst. Chem.*
W. J. Morse, B. S., *Asst. Bot.*
E. S. Gregg, *Dairyman.*
Mary A. Benson, *Sten.*
E. H. Powell, *Treas.*

LINES OF WORK.

No change has been made during the past year in the main lines of work pursued by the Vermont Station. These have included chemical studies of potatoes, artichokes, maple sap, and fertilizers; horticultural investigations with special attention to the classification, pollination, and hybridization of plums; botanical investigations, especially on the diseases of apples, potatoes, and carrots, and on weeds, the purity of seeds, and the physiology of the flow of maple sap; entomological studies, especially on the forest tent caterpillar; and feeding experiments with dairy cows. The work in dairying is directed mainly toward the improvement of methods of experimentation in feeding milch cows. The horticulturist is continuing the work in the propagation of plums and has made some interesting experiments in combinations of stocks and grafts. The station is conducting nutrition investigations in cooperation with this Office, the special subject of investigation being farmers' dietaries. The inspection of fertilizers, feeding stuffs, and creamery glassware has been continued

as heretofore. During the year the horticulturist of the station has published two books, one on Plums and Plum Culture, the other on Fruit Harvesting, Storing, and Marketing.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	3,446.28
Farm products	5,542.46
Total	23,988.74

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 81–86.

Bulletin 81, pp. 56.—Principles and Practice of Stock Feeding.—A popular discussion of this subject, including tables of feeding standards, the composition and digestibility of feeding materials, etc.

Bulletin 82, pp. 24.—Analyses of Commercial Feeding Stuffs.—Analyses of 375 samples of commercial feeding stuffs inspected in compliance with the State law, the chief provisions of which are given.

Bulletin 83, pp. 12, pls. 4.—Apples of the Fameuse Type.—The Fameuse apple is taken as a central type of several different varieties, and is discussed as regards history, variation, pomological status, etc., and historical and descriptive notes are given on 12 varieties belonging to the Fameuse group.

Bulletin 84, pp. 16.—Analyses of Commercial Feeding Stuffs.—Analyses of 230 samples of commercial feeding stuffs with a discussion of the results.

Bulletin 85, pp. 12, figs. 2.—Potato Scab and Its Prevention.—A popular discussion of the occurrence and appearance, cause, development and spread, and prevention of potato scab.

Bulletin 86, pp. 24.—Analyses of Commercial Fertilizers.—Analyses and valuations of samples of 40 brands of fertilizers, with tables showing the composition of the leading brands of fertilizers examined by the station during the past five years, 1896–1900.

GENERAL OUTLOOK.

Adherence to a few important lines of work continues to be the policy of the Vermont Station. Among the leading subjects of investigation are dairying, maple-sugar production, fruit production, and potato growing. For some time past, and especially during the last

year, the station has been making a very thorough and ingenious study of the flow of maple sap under varying conditions, the botanical and chemical departments cooperating in the work. A large amount of data has been collected and is being prepared for publication. The botanist has published the results of extended investigations conducted principally in the laboratory of Plant Pathology of this Department on a soft rot of carrot and other vegetables, and the horticulturist has published the results of interesting and valuable studies on the propagation and pollination of plums and on plum-tree canker. These and the work on the control of tuberculosis in cattle are considered of great practical benefit to the farmers of the State. Press bulletins and attendance at farmers' institutes have been found to be most effective means of keeping in touch with farmers. The station officers, however, especially the director, do less institute work than formerly, the responsibility for this work being more fully assumed by the State board of agriculture.

VIRGINIA.

Virginia Agricultural Experiment Station, *Blacksburg.*[a]

Department of Virginia Agricultural and Mechanical College.

GOVERNING BOARD.

Board of control: J. T. Brown, *Brierfield;* D. M. Cloyd, *Dublin;* B. R. Selden, *Richmond;* W. R. Robertson, *Plasterco;* J. M. McBryde (*Pres. College*), *Blacksburg.*

STATION STAFF.

J. M. McBryde, Ph. D., LL. D., *President of the College and Director.*

W. B. Alwood, *V. Dir.; Hort., Ent., and Myc.*
E. A. Smyth, jr., M. A., *Biol.*
D. O. Nourse, B. S., *Agr.*
R. J. Davidson, M. A., *Chem.*
H. L. Price, B. S., *Asst. Hort.*
E. P. Niles, D. V. M., *Vet.*
John Spencer, V. S., *Asst. Vet.*
J. H. Gibboney, *Asst. Chem.*
J. B. Huffard, *Asst. Chem.*

C. I. Wade, *Treas.*

LINES OF WORK.

The work of the Virginia Station during the past year has been along the same general lines as heretofore and has included feeding experiments with cattle and pigs; chemical analyses of feeding stuffs, fertilizers, varieties of apples and the pomace of these varieties; study of the problems presented in the fermentation of cider and vinegar; collection and study of foreign types of apples, with a view to supplying qualities lacking in native fruits for the production of the finer grades of ciders and vinegars; experiments with field crops, and veterinary and entomological investigations. The fermentation studies

[a] Express and freight address, *Christiansburg Depot.*

include a critical study of the alcoholic ferments and allied forms that interfere with sound processes of fermentation and of those fungi that impair the quality of alcoholic beverages; separation and study of races of yeast organisms, with regard to their power of producing strong, well-ordered fermentation and the character of flavor and bouquet produced in liquor, and a practical study in the fermentation of must of many varieties of native fruits. The work with cider is being conducted in cooperation with the Bureau of Chemistry of this Department, with which Bureau also the station is cooperating in sugar-beet investigations. A soil survey is being conducted in cooperation with the Bureau of Soils of this Department, and chemical work with soils is being done for the Association of Official Agricultural Chemists of the United States.

During the year the main barn and the piggery and abattoir (Pl. VII, fig. 1) were completed by the college. The former has stable room for 150 head of cattle and is well adapted for feeding experiments. The latter contains excellent facilities for feeding and slaughtering pigs and is built largely for experimental work. There is also a new machinery barn, which contains commodious quarters for machinery, wagons, tools, harness, etc., a carpenter shop, blacksmith shop, and a quarantine room for sick animals. The assistant chemist of the station has been granted leave of absence for two years to pursue studies in Germany. Under the provision of State laws the horticulturist continues the inspection for insect pests and the veterinarian manufactures and distributes blackleg vaccine. Members of the staff assist at farmers' institutes, which are under the management of the commissioner of agriculture.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15, 000. 00
Farm products	3, 994. 51
Total	18, 994. 51

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 103–110 and the Annual Report for 1900.

Bulletin 103, pp. 12, figs. 2.—Blackleg Vaccine.—A revision of Bulletin 90 of the station giving directions for the preparation and use of blackleg vaccine.

Bulletin 104, pp. 16, pl. 1.—The Prevention of Texas Cattle Fever

and the Amended Laws Controlling Contagious and Infectious Diseases.—A brief review of the experimental work done on the cattle tick and the Texas fever by the Bureau of Animal Industry of this Department and the agricultural experiment stations in Texas, Missouri, and Louisiana, and the text of the laws of Virginia for the control of infectious and contagious diseases of live stock.

Bulletin 105, pp. 8.—Steer Feeding.—Data for a test with 7 steers of the relative feeding value of whole corn and corn-and-cob meal used in combination with other foods.

Bulletin 106, pp. 20, pls. 6.—Barns.—The specifications of a wooden hillside barn erected at the station at a cost of between $6,000 and $7,000 are given in full and the plans are briefly discussed.

Bulletin 107, pp. 26.—Feeding Stuffs.—A general discussion of feeding stuffs with analyses of a number of samples.

Bulletin 108, pp. 12.—Animal Parasites, I.—A brief classification of the parasites of domestic animals according to the natural orders to which they belong.

Bulletin 109, pp. 12, pl. 1, fig. 1.—Animal Parasites, II.—Brief popular notes on the Culicidæ, with suggestions of remedies against these insects.

Bulletin 110, pp. 16, figs. 5.—Animal Parasites, III.—Brief popular notes on *Gastrophilus equi*, *G. hœmorrhoidalis*, *G. nasalis*, ox bot fly, ox warble fly, and sheep bot fly.

Annual Report, 1900, pp. 14.—This contains the organization list of the station, a report of the director consisting mainly of a summary of the bulletins issued during the year, a summary of meteorological observations, a financial statement for the fiscal year ended June 30, 1900, and brief departmental reports.

GENERAL OUTLOOK.

The Virginia Station continues to give much attention to the investigation of means for utilizing fruit products, especially those of the apple, which is one of the most important crops of the State. The chemical and horticultural departments are cooperating in this work, and their investigations, extending as they do to the study of yeasts, musts, ciders, vinegars, pulp, etc., cover more phases of the problem than are covered by any other station in this country. The station is also studying other problems in fruit growing, such as the introduction of improved varieties, management of orchards, destruction of insect pests, etc. The soil survey recently undertaken will enable the station to determine the sections of the State best adapted to apple growing and those adapted to other agricultural productions. Attention is being given also to problems in animal husbandry, especially feeding experiments with live stock, for which important additions to the college and station buildings and equipment have recently been made.

WASHINGTON.

Washington Agricultural Experiment Station, *Pullman.*

Department of Washington Agricultural College and School of Science.

GOVERNING BOARD.

Board of Regents: F. J. Barnard, *Seattle;* R. C. McCroskey, *Garfield;* H. W. Canfield, *Colfax;* J. W. Stearns (*Treas.*), *Tekoa;* H. D. Crow, *Spokane.*

STATION STAFF.

E. A. Bryan, M. A., *President of the College and Director.*
E. E. Elliott, M. S., *Agr.*
Chas. V. Piper, M. S., *Bot. and Zool.*
S. W. Fletcher, *Hort.*
Elton Fulmer, M. A., *Chem.*
Sofus B. Nelson, D. V. M., *Vet.*
H. S. Davis, *Asst. Zool.*
R. E. Snodgrass, *Asst. Ent.*
R. W. Thatcher, B. S., *Asst. Chem.*
R. Kent Beattie, M. A., *Asst. Bot.*
O. L. Waller, *Irrig. Engin.*
David A. Brodie, B. S., *Supt. Puyallup Station.*
J. S. Cotton, *In Charge of Cooperative Range Experiments.*

LINES OF WORK.

The work of the Washington Station during the past year has included experiments with grasses and forage plants for farms and for the ranges in the semi-arid belt; cultural experiments with cereals; extensive breeding experiments with wheat; rotation experiments; feeding experiments with steers, pigs, and sheep; chemical investigations with soils, sugar beets, potatoes, and wild oats; horticultural investigations, including cover crops for orchards, spraying for apple scab, potash fertilizers for fruit, smudging for protection from frost, orchard pollination, vegetable gardening, cooperative work in strawberry culture, and to determine the causes of failure of Italian prunes in Clarke County; study of diseases and insects injurious to grain, fruit, and garden vegetables; irrigation investigations; veterinary work, including an investigation of moldy hay as a supposed cause of spinal meningitis; experiments with plants poisonous to sheep, and a continuation of studies of glanders and tuberculosis, and the investigation of means for controlling or eradicating the ground squirrel. The irrigation investigations are conducted in cooperation with this Office, and the experiments with grasses and forage plants for the improvement of the Northwestern ranges in cooperation with the Bureau of Plant Industry of this Department. Work at the Puyallup Substation is being continued with State funds, but the station has withdrawn entirely from its connection with the oyster-culture station on Puget Sound.

The agriculturist has given much attention to the breeding of wheats in order to develop a fall club wheat, and has succeeded already in making some quite valuable improvements. The work at Yakima, Puyallup, and Pullman with forage plants for hay and pasture is partly carried on in cooperation with farmers and is giving a remarkable

impetus to the production of forage. Pig-feeding experiments with different grains have for the third time shown the best results for wheat, which produces a firmer and leaner meat than other grains. During the year a greenhouse and insectary, costing $1,000, has been erected, and cattle and hogs, costing over $1,000, bought with State funds. The State has also provided $25,000 for a new chemical building and equipment which will furnish better facilities for the station, $1,250 a year for two years for State veterinary work, and $500 for a contagious-disease ward. The expense of farmers' institutes is borne by communities, the transportation being furnished by the railroads. One railroad last year gave passes to over 100 farmers to visit the college and station, selecting ten farmers from a township.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	9,848.96
Miscellaneous, including fees and farm products	565.98
Total	25,414.94

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 43–46 and the Annual Reports for 1899 and 1900.

Bulletin 43, pp. 48.—Rational Stock Feeding.—A revision of Bulletin 29 of the station, discussing in a popular manner the principles of stock feeding.

Bulletin 44, pp. 13.—Fish Scrap Fertilizers.—A discussion of the value and importance of dried fish and fish-scrap fertilizers.

Bulletin 45, pp. 12, fig. 1.—A Preliminary Report of Poison Parsnip in Western Washington.—An account of experiments in feeding *Cicuta vagans* to steers to determine if hay containing this plant was responsible for a case of poisoning of cows. Tests to determine if several other plants are poisonous to stock were also made.

Bulletin 46, pp. 15, pls. 4, fig. 1.—Potato Blight and Its Treatment.—A popular description of potato blight, results of spraying experiments with Bordeaux mixture for the prevention of this disease, and directions for preparing Bordeaux mixture.

Annual Report, 1900, pp. 8.—A report of the director reviewing briefly the different lines of station work, and giving a financial statement for the fiscal year ended June 30, 1900.

GENERAL OUTLOOK.

The Washington Station is doing much for the advancement of agriculture in the State, especially along lines related to the production of field crops and live stock. One need of the wheat growers is a fall-sown wheat that will not winterkill, and this the agriculturist has tried to obtain. The production of grasses and other forage crops and the improvement of the ranges are very important problems related to the development of animal production in the State, which the station is investigating. Closely related to these also are the feeding experiments and the veterinary investigations. The continued success and consequent growth of the college with which this station is connected, as well as the increasing importance of the agriculture of the State, make it very desirable that this station should have a director who can give his time and energy fully to the study and administration of the important affairs of this department of the college. It is hoped, therefore, that the offices of president of the college and director of the station will be separated in the near future.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown.*

Department of West Virginia University.

GOVERNING BOARD.

Board of Regents: E. M. Grant, *Morgantown;* C. E. Haworth, *Huntington;* J. W. Hale, *Princeton;* C. M. Babb, *Falls;* J. R. Trotter, *Buckhannon;* D. C. Gallaher, *Charleston;* J. B. Finley, *Parkersburg;* C. D. Oldham, *Moundsville;* W. J. W. Cowden, *Wheeling.*

STATION STAFF.

D. B. Purinton, Ph. D., LL. D., *President of the University.*

J. H. Stewart, M. A., *Dir.; Agr.*
A. D. Hopkins, Ph. D., *V. Dir.; Ent.*
Bert H. Hite, M. S., *Chem.*
K. C. Davis, Ph. D., *Hort.*
Gilbert M. John, *Asst. Hort.*
W. E. Rumsey, B. S. A., *Asst. Ent.*
C. D. Howard, H. S., *Asst. Chem.*
Frank B. Kunst, *2d Asst. Chem.*
Horace Atwood, M. S., *Asst. Agr.*
John Wallace, *Sten. and Clerk.*
M. A. Stewart, *Libr.*
W. J. White, *Auditor.*

A. R. Whitehill, Ph. D., *Treas.*

LINES OF WORK.

The work of the West Virginia Station during the past year has been along the same lines as heretofore pursued, including field experiments with cereals, forage crops, and grasses; a continuation of a comprehensive series of experiments designed to study some of the important problems in soil fertility, involving the use of commercial fertilizers, barnyard manure, green manures, and crop rotations; feeding experiments with sheep; experiments with poultry with reference to the production of meat and eggs, the study of the different feeds

for young chickens, the incubation of chickens, and the preservation of eggs; horticultural work in spraying for insects and plant diseases; experiments with new insecticides and fungicides, including a thorough study of the various crude petroleums and combinations of petroleum products for San José scale; experiments in breeding roses and carnations; forcing experiments with lettuce and other greenhouse crops; field experiments with a variety of horticultural crops, especially cranberries, on mountain glade lands of the State; fertilization of orchards; a study of causes of winterkilling in peach orchards; chemical work, including analyses of soils, commercial fertilizers, forage crops, grains, fruits, fruit juices, meats, materials used in preparations of insecticides and fungicides, mineral and drinking waters, etc.; a study of the effect of high pressure in the preservation of perishable foods; entomological work, including investigations of the Hessian fly, periodical cicada, jointworm, and insects injurious to timber and timber products.

During the year the legislature of the State amended the fertilizer law so as to bring it more nearly in accordance with modern requirements, and enacted a law providing for the inspection of nurseries and orchards, carrying with it a sufficient appropriation for the inspection, and placing the execution of the law in the hands of the director of the station. The station is continuing its soil survey with the intention of finally providing a complete soil map of the State. Special attention has been given to investigations of the periodical cicada, Hessian fly, and insects injurious to forests. The study on the effect of pressure in the preservation of perishable food stuffs has been continued with encouraging results, especially in the case of fruits and fruit juices, which it seems may be preserved in excellent condition by the application of relatively small pressures at ordinary temperature for a few days. For this work apparatus has been designed by those having the experiments in charge. A new library building for the university, which will afford better facilities for the preservation of station records, is in process of construction. During the year Dr. J. H. Raymond, president of the university, resigned, and was succeeded by Dr. D. B. Purinton, who was president of the Denison College, Ohio. L. C. Corbett, horticulturist, resigned to accept a position in this Department, and was succeeded by Dr. K. C. Davis, of Minnesota.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	6,062.50
Farm products	326.84
Miscellaneous	1,056.67
Total	22,446.01

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–75 and the Annual Reports for 1899 and 1900.

Bulletin 66, pp. 40, figs. 23.—Fruit Diseases and How to Treat Them.—Descriptive notes on the more common fruit diseases with suggestions for their prevention, directions for the preparation and use of insecticides and fungicides, and a spray calendar.

Bulletin 67, pp. 18, pls. 2, map 1.—The Hessian Fly in West Virginia and How to Prevent Losses from Its Ravages.—Observations and summarized information on the life history and means of controlling the Hessian fly.

Bulletin 68, pp. 76, pls. 3, figs. 4, maps 9.—The Periodical Cicada or Seventeen-year Locust in West Virginia.—This bulletin contains a brief account of the anatomy, habits, life history, and broods of the periodical cicada; notes from correspondence relating to the distribution and extent of broods occurring within the limits of the State; maps showing the distribution of the broods which will emerge in 1901, 1902, and 1905, etc.

Bulletin 69, pp. 20, pl. 1.—Report on Examination of Wheat Stubble from Different Sections of the State.—The Jointworm in Wheat.—Results of the examination of wheat stubble from 24 counties of the State for the presence of the Hessian fly, and a brief account of the appearance, life history, and habits of the jointworm with suggestions for combating this insect.

Bulletin 70, pp. 32, pls. 8, figs. 6.—Spraying.—Experiments here reported included a test of the practical value of spraying orchards with standard fungicides and insecticides; experiments in using a combination of Bordeaux mixture and kerosene; experiments in making Bordeaux mixture by mechanical methods; a test of a combination of tobacco and kerosene emulsion as a remedy for rose bugs; and experiments in combating the San José scale with whale-oil soap, dilute kerosene in a 25 per cent mechanical mixture with water, and pure kerosene and crude petroleum in a 20 per cent mixture with water.

Bulletin 71, pp. 20, figs. 2.—Poultry Experiments.—The poultry houses recently built at the station are described, and experiments including a test of the importance of warm houses in the production of eggs, a comparison of meat meal with ground fresh meat and bone for egg production, a comparison of rations with wide and narrow nutritive ratios for growing chickens, a test of the importance of a liberal supply of green food for laying hens, and a test concerning the fertility of eggs are reported.

Bulletin 72, pp. 32.—Commercial Fertilizers.—Analyses and valuations of 287 samples of fertilizing materials examined during 1900.

Bulletin 73, pp. 16.—Poultry Experiments.—Three tests of the loss of weight in eggs during incubation are reported.

Bulletin 74, pp. 32, figs. 3.—Cold Storage.—The profits of cold storage are discussed, experiments with apples and chestnuts in cold storage are reported in detail, and chapters on "moisture in cold storage" and "materials of construction," taken from books relating to cold storage, are appended. The author outlines a plan for the building of a cold-storage room, giving methods of construction and materials used.

Bulletin 75, pp. 98, pls. 7, figs. 5, map 1.—Apple Districts of West Virginia.—Preliminary notes are given on the apple industry in West Virginia and on top-grafting old trees; and information obtained from correspondents relative to the condition of orchards after the severe frost of March 29, 1898, the areas in the State best suited to apple culture, and the relative value of 114 varieties of apples and 5 varieties of crab apples for each county of the State is presented by means of tables and maps.

Annual Report 1899, pp. 45, pls. 5, fig. 1.—A financial statement for the fiscal year ended June 30, 1899; a report of the director giving a general review of station work during the year; and departmental reports reviewing in greater detail the different lines of station work, that of the entomologist giving in addition a detailed statement of various trips made in the State for the purpose of studying forest insects and life zones, and that of the horticulturist a detailed illustrated account of an improved auxanometer and a transpiration apparatus, with some explanations as to the uses of these instruments in studies in plant physiology.

Annual Report, 1900, pp. 24.—A financial statement for the fiscal year ended June 30, 1900; a report of the director reviewing at some length the different lines of station work and summarizing briefly some of the results of investigations previously reported; a table showing the quantity and value of commercial fertilizers sold in the State during the last five years; and brief statements on the results of experiments on the effect of pressure in the preservation of perishable food stuffs and on methods of preserving eggs.

GENERAL OUTLOOK.

No branch of agriculture in West Virginia is forging ahead so rapidly as that of fruit growing. It is officially reported that during the year 1900 from 2,000 to 2,500 acres of apple orchards were planted in Berkeley County alone, while in other counties there was a large increase in the acreage of apple orchards, and many hundred thousand peach trees were set out. Station officers are working hand in hand with fruit growers for the development of this industry, the work

including cooperative experiments in the renovation of old and the establishment of new orchards, experiments in building up worn-out soils, entomological investigations, experiments with spraying materials, etc. The work is very popular and is bringing the station into cordial relations with the people of the State, as is evidenced by the recent legislation in support of orchard and nursery inspection. The investigations of the station, in cooperation with the Division of Entomology of this Department, have been of more than local importance. The experiments with field crops, fertilizers, and poultry are now well organized and are proceeding along useful lines.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison.*

Department of the University of Wisconsin.

GOVERNING BOARD.

Board of Regents: J. H. Stout (*Pres.*), *Menomonie;* State Superintendent of Instruction, *Madison;* President of University, *Madison;* H. C. Taylor, *Orfordville;* Edward Evans, *La Crosse;* James C. Kerwin, *Neenah;* Wm. F. Vilas, *Madison;* B. J. Stevens (*V. Pres.*), *Madison;* Almah J. Frisby, *Milwaukee;* E. A. Edmonds, *Oconto Falls;* Arthur J. Puls, *Milwaukee;* Geo. F. Merrill, *Ashland;* D. T. Parker, *Fennimore;* Arthur M. Pereles, *Milwaukee;* Maj. C. Mead, *Plymouth;* E. F. Riley (*Sec.*), *Madison.*

STATION STAFF.

E. A. Birge, Ph. D., D. Sc., *Acting President of the University.*

W. A. Henry, B. Agr., *Dir.*
S. M. Babcock, Ph. D., *Asst. Dir. and Chief Chem.*
A. R. Whitson, B. S., *Agr. Phys.*
E. S. Goff, *Hort.*
Frederic Cranefield, *Asst. in Hort.*
E. H. Farrington, M. S., *Dairy Husb.*
U. S. Baer, *Cheese Making.*
W. L. Carlyle, B. S. A., *Animal Husb.*
T. F. McConnell, jr., *Asst. Animal Husb.*
H. L. Russell, Ph. D., *Bact.*
John F. Nicholson, *Asst. Bact.*
F. W. Woll, M. S., *Chem.*
Alfred Vivian, *Asst. Chem.*
R. A. Moore, *Asst. Agr.*
F. J. Wells, *Asst. Agr. Phys.*
Leslie H. Adams, *Farm Supt.*
Ida Herfurth, *Clerk.*
Daisy G. Beecroft, *Libr. and Sten.*

LINES OF WORK.

The work of the Wisconsin Station during the past year has included a large number of feeding experiments with horses, cattle, hogs, and pigs; investigations in soil physics, including studies of muck soils and movement of nitrates in the soil; irrigation investigations; horticultural work, including studies of the plum, commercial orchard work, surface *v.* subwatering for ornamentals, and experiments in pinching raspberries; chemical and bacteriological investigations with silage; bacteriological studies of tuberculosis and anthrax; and dairy investigations, including studies and experiments with skim milk, condensed milk, and cream, and studies of a number of problems in cheese

ripening, including temperature variations from below zero to above 70° F. Variety tests of cereals have been carried on and a striking demonstration made of the value of formaldehyde for preventing oat smut. A cross between razor-back pigs and Poland Chinas has been tried. The feeding experiments have included cost of ration for colts, narrow *v.* wide ration for steers, dried *v.* cooked feeds for steers, peas *v.* corn for pigs, shelled *v.* ground corn for pigs, corn products *v.* oat products for sheep and for cows, sorghum *v.* corn fodder for cows, rape for milch cows, and salt for cows. The irrigation experiments have included, among other things, the use of water in a rotation experiment on 10 acres with corn, potatoes, and grass, and have been conducted in cooperation with this Office. The station is also cooperating with the Bureau of Chemistry of this Department in sugar-beet investigations, and with the Bureau of Plant Industry of this Department in studies of the influence of origin of red-clover seed on yield of crop. In cooperation with the breeders' association the station tests cows for farmers, to determine the amount and quality of milk produced.

The State legislature at its last session appropriated $150,000 for a new agricultural building and made an addition of $10,000 to the maintenance fund of the college. The new building will be 200 by 63 feet, four stories high, with a two-story octagon in the rear for library and auditorium, and will furnish additional facilities for both the station and the college of agriculture. This building is now in process of construction, but will not be completed before January, 1903. The legislature also passed a law placing the inspection of feeding stuffs in the hands of the station. During the year an experimental union was formed among the graduates and former students of the college, similar in object and character to the Ontario Agricultural and Experimental Union. The soil physicist of the station, Prof. F. H. King, resigned recently to accept a position in the Bureau of Soils of this Department, and the assistant soil physicist, A. R. Whitson, has been placed in charge of the department. During the past year Professor King published a text-book of the physics of agriculture.

In 1899 the Wisconsin legislature passed a joint resolution providing that a medal be presented to Dr. S. M. Babcock, chemist of the experiment station, who worked out and perfected the milk test which bears his name, and has made many other contributions of the greatest value to dairying. A committee appointed by Governor Scofield procured a medal and arranged the details for its presentation. This ceremony took place at a joint session of the senate and assembly in the State Capitol at Madison on the evening of March 27, 1901. Gov. Robert M. La Follette presided at the meeting and gave an address in which he paid high tribute to Dr. Babcock for his inventions and discoveries and for his unselfish dedication of them to the public. Ogden H. Fethers, regent of the university, made the

presentation address, to which Dr. Babcock responded. Other addresses were given by Senator W. H. Hatton, Assemblyman G. W. Gilman, Director W. A. Henry, and ex-Governor W. D. Hoard. The medal (Pl. VI, figs. 1 and 2) is of golden bronze, 5 inches in diameter. Upon the obverse are symbolical figures representing Agriculture and Science bringing their offerings to State, who sits enthroned on a raised dais. The reverse contains the preamble to the joint resolution, surrounded by an oak wreath, outside of which are the encircling words "The State of Wisconsin Presents to Professor Babcock this Medal."

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	[a]15,000.00
Fees	125.00
Total	30,125.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 84–87; Special Bulletin, March, 1901; and the Annual Report for 1900.

Bulletin 84, pp. 16, figs. 4, map 1.—Bovine Tuberculosis in Wisconsin.—A discussion of the present status of bovine tuberculosis in Wisconsin, a statistical account of the percentage of tuberculous animals in other States, and brief notes on the geographical distribution of tuberculosis in Wisconsin, the spread of the disease from herd to herd, its introduction through tuberculous animals, the advisability of State quarantine, mode of dissemination within a herd, and methods of treating reacting animals and controlling the disease.

Bulletin 85, pp. 48, pl. 1, figs. 10.—Development and Distribution of Nitrates and Other Soluble Salts in Cultivated Soils.—This is in large part a reprint from the report of the station for 1900, with more detailed data, of an account of investigations of the amount of nitric nitrogen in field soils under crop conditions throughout the season, but contains also accounts not previously reported of investigations on the limit of nitric nitrogen in field soil at which the leaves of corn and oats turn yellow, difference between the amounts of nitric nitrogen under growing crops and in cultivated fallow ground at the same time, distribution of nitrates and other soluble salts in soil under growing

[a] Estimated amount of State appropriation for the college of agriculture and experiment station spent for experimental purposes.

FIG. 1.—WISCONSIN STATION—BABCOCK MEDAL, OBVERSE.

FIG. 2.—WISCONSIN STATION—BABCOCK MEDAL, REVERSE.

corn as it comes into full tassel, the strength of salt solutions under field crops, results of Warington's nitric nitrogen studies at Rothamsted, method of determining soluble salts and nitric nitrogen in field soils, sensitiveness of the methods used in the study of nitric nitrogen and soluble salts, and possible error in results due to the methods.

Bulletin 86, pp. 10.—Analyses of Licensed Commercial Fertilizers, 1901.—The text of the Wisconsin fertilizer law, notes on the sources of fertilizing ingredients in fertilizers and on the valuation of fertilizers, and analyses of 5 samples of fertilizers sold in the State during the year.

Bulletin 87, pp. 31, pls. 4, figs. 8.—Native Plums.—This bulletin considers the following topics: Methods of plum culture, culinary uses of native plums, varieties, blooming period of plums, thickness of the skins, and the longevity of American plums. Some data are also presented on the self-fertility or sterility of native plums.

Special Bulletin, March 1901, pp. 4, fig. 1.—The Prevention of Oat Smut.—A popular description of oat smut and methods of prevention.

Annual Report, 1900, pp. 360, pls. 14, figs. 63, maps 2.—In addition to a report of the director on the work and publications of the station during the year, lists of exchanges and acknowledgments, and a financial statement for the fiscal year ended June 30, 1900, the following work is reported in greater or less detail: A comparison of whole corn and corn meal, made with 2 lots of 14 pigs each; a preliminary experiment with 16 pigs in regard to the effect of certain foods on the production of lean meat; a test, with 30 pigs, of the feeding value of rape; tests, with 47 breeding ewes, to compare different rations for winter feeding, especially to determine the value of corn fodder and silage; an experiment with 16 cows, lasting twelve weeks, to study the proportion of grain feed to coarse fodder best adapted for the economical production of milk and butter; official tests of 110 Holstein, 7 Guernsey, 2 Shorthorn, and 8 Red Polled cows; investigations of the cause of error in some incorrect tests with turbine Babcock testers, the effect of temperature on tests of skim milk by the Babcock test, and the determination of fat in sweetened condensed milk by the Babcock test; the calculation of dividends for milk and cream at the same factory; tests of a patent churn in comparison with a barrel churn; a description and tests of a method for the determination of salt in butter designed for factory use; investigations to determine the effect of different quantities of rennet in cheese ripening; experiments in making silage under laboratory conditions for the purpose of studying the changes which occur in the formation of good silage; a description of a form of apparatus devised at the station for conducting experiments in the respiration of vegetable tissues, particularly for the study of the phenomena attending the production of heat in silage; investigations, under commercial conditions, conducted for the purpose of retest-

ing some of the more recent work in regard to the thermal death point of tubercle bacilli; investigations of an outbreak of anthrax traceable to tannery refuse, and experiments to test the value of formaldehyde in destroying the anthrax bacillus; a study of the influence of the right amount and the right distribution of water in crop production, including culture and irrigation experiments; a series of experiments to determine the extent and character of unavoidable losses in the production of silage; tests of the relative effectiveness of various potash salts on black-marsh soils; studies of the influence of tillage, season, and cropping on the total amounts, relative proportions, and distribution of nitric nitrogen and soluable salts in soils; data for tests of 35 varieties of oats, 15 of barley, 10 of spring wheat, 6 of peas, 2 of spelt, and 1 of spring rye; analyses of sugar beets, and variety and fertilizer tests; analyses of 7 samples of commercial fertilizers; tables for use in Kjeldahl method for determination of nitrogen; investigations on the origin and development of flower buds, especially those of the peach and strawberry; experiments in pinching raspberry shoots; observations on the resumption of root growth in the spring; experiments to study the effects of using immature seed corn and tomato seed; studies on duration of the growth period in fruit trees; a description of rooms for cheese making and curing recently provided at the station; a record of the university dairy herd, kept partly for the purpose of comparing the milk and butter production of cows of the special-purpose dairy type and cows of the dual-purpose type; and the text of the Wisconsin fertilizer law.

GENERAL OUTLOOK.

The Wisconsin Station has only recently inaugurated experiments in agronomy, and at present is confining this work largely to cereals and forage plants. Important investigations regarding the composition and treatment of muck soils have been continued. An interesting feeding experiment with cows was conducted indicating that the constituents in different crops have a different effect on the animal. Long-continued feeding of salt to cows showed a marked beneficial effect. The feeding value of sorghum for cows was found to be better than that of corn fodder, and mature rape fed to cows in quantities as large as 40 to 60 pounds per day did not perceptibly affect the flavor of the milk. Investigations with succulent green corn *v.* mature corn for silage have shown that a sweeter silage is obtained from mature corn. In the cheese-ripening studies about 100 cheeses were cured at temperatures varying from below zero to above 70° F. The results show the great advantages of low-temperature curing in point of safety and greater control of the process, and demonstrate conclusively that cheese of excellent quality can be produced under such conditions of curing. The most notable result of the work of the past year has

been the discovery of the fate of the sugar in the process of cheese making and ripening. The transformed sugar has been traced and accounted for, showing the relation between the amount of sugar used and the quality of the cheese. This discovery goes a long way toward explaining some of the purely empirical rules of cheese making.

The Wisconsin College of Agriculture continues to concentrate the efforts of its strongest men on a few important lines of investigation in the experiment station, with results that fully justify the policy. That these results are appreciated in the State is evidenced by the liberal appropriations made by the legislature during the year for buildings and maintenance, by the graceful tribute to the chemist of the station in awarding him a medal for his inventions and discoveries, and by the very large and growing correspondence with farmers representing all phases of agricultural practice in the State. The short courses in the college continue to be well patronized, and a movement has been inaugurated for extending the influence of both college and station by means of an experimental union of students organized to conduct cooperative experiments.

WYOMING.

Wyoming Agricultural Experiment Station, *Laramie.*

Department of the University of Wyoming.

GOVERNING BOARD.

Board of Trustees: Otto Gramm (*Pres.*), *Laramie;* T. F. Burke (*V. Pres.*), *Cheyenne;* Grace R. Hebard (*Sec.*), *Cheyenne;* J. C. Davis (*Treas.*), *Rawlins;* A. C. Jones, *Laramie;* S. Conant Parks, *Lander;* J. A. Beckwith, *Evanston;* H. L. Stevens, *Laramie;* Mortimer Jesurun, *Douglas;* T. T. Tynan (*State Supt. of Public Instruction*), *Cheyenne;* E. E. Smiley (*Prss. University*), *Laramie.*

STATION STAFF.

E. E. Smiley, D. D., *President of the University and Director.*

Frank E. Emery, M. S. A., *V. Dir.; Agr. and Hort.*
Aven Nelson, M. S., M. A., *Bot.*
E. E. Slosson, M. S., *Chem.*
W. C. Knight, M. A., Ph. D., *Geol.*
C. B. Ridgaway, M. A., *Phys. and Math.*
Grace R. Hebard, M. A., Ph. D., *Sec.*
Burton P. Fleming, B. S., *Irrig.*

Elias E. Nelson, M. A., *Hort. and Agros.*

LINES OF WORK.

The work of the Wyoming Station during the past year has included irrigation and alkali investigations, especially measurements of water, the duty of water with different crops, the effect of irrigation on alkali in the soil, experiments with economic plants on alkali soils, and a study of evaporation from soils containing different amounts of alkali; rotation experiments, continuous cropping, and cropping with and without summer cultivation; experiments with alfalfa as a soil renovator; variety tests with oats and wheat; smut and cultural experi-

ments with oats; experiments with cultivated and native forage plants; horticultural investigations with native and other fruits and garden vegetables; feeding experiments with pigs and lambs. The station is cooperating with this Office in irrigation investigations and with the Bureau of Plant Industry of this Department in plant breeding and quite extensive investigations of grasses and forage plants for alkali soils.

The experiments in feeding pigs included the use of alfalfa for growing pigs and of artichokes for fattening them; but it was found that too large a percentage of costly grain was needed for economical pork production. During the winter an experiment in feeding lambs was carried to successful conclusion. In another experiment the feeding qualities of capons and cockerels were compared. Early in the year a number of greenhouse experiments were started, but these were entirely destroyed by a fire which burned part of the greenhouse. However, the building has been repaired and a new potting house has been erected. The new $35,000 Science Hall (Pl. VII, fig. 2), which is just being completed, will furnish much better facilities for a number of departments of station work, especially those of chemistry and geology. The station does not carry on any institute work, but the agriculturist and botanist have delivered addresses at conventions of stockmen. The publication of press bulletins has been started.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	528.20
Total	15,528.20

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 45 and the Annual Report for 1900.

Bulletin 45, pp. 148, pls. 26, map 1.—A Preliminary Report on the Artesian Basins of Wyoming.—This is a preliminary treatise on the geology and artesian basins of Wyoming, based upon field notes collected during the past four years, accompanied by a map embodying "all that is known of the geology of Wyoming up to date," the object of the publication being to explain the essential features of the artesian basins of the State, so that artesian wells may be located.

Annual Report, 1900, pp. 457, pls. 39, figs. 12, dgm. 1, map 1.—This includes notes on the origin and purpose of the station; brief abstracts

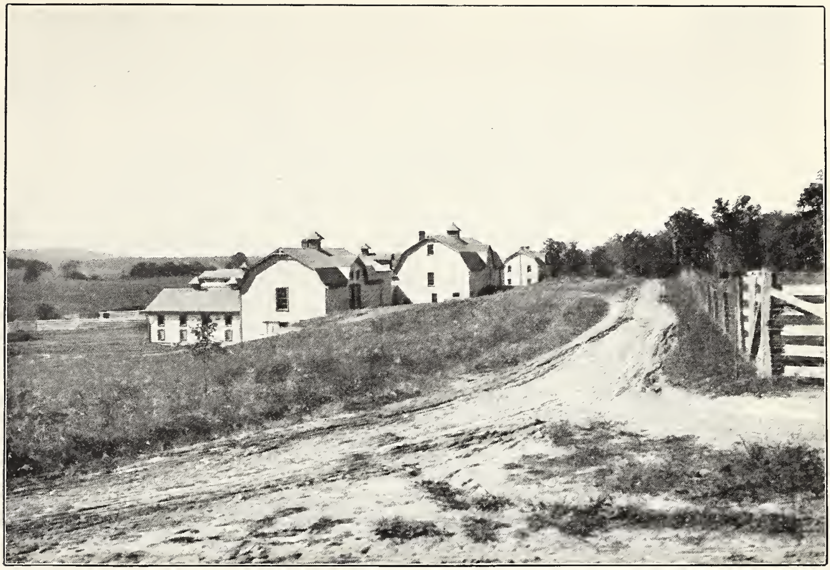


FIG. 1.—VIRGINIA COLLEGE AND STATION—BARNS AND PADDOCKS.

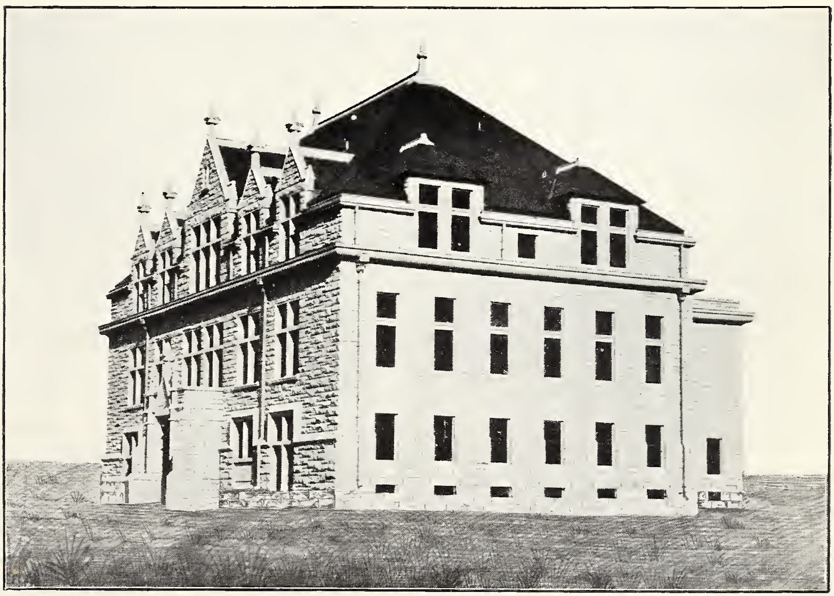


FIG. 2.—WYOMING COLLEGE AND STATION—SCIENCE HALL.

of the bulletins issued during the year; plans of station work for 1900–1901; reports of the director and heads of departments; a financial statement for the fiscal year ended June 30, 1900; studies of the effect of alkali on the germination and growth of plants, the rate of absorption of salts from solution, and the evaporation of water from salt solutions and plants; determinations of the amount of alkali in the soil at depths of from 3 inches to 3 feet on different parts of the experiment farm; measurements of the duty of water in irrigation; observations during 1899 on the amount of water necessary to produce a maximum crop, and the results of tests of two subirrigation systems at the station; a report on tests of a large number of cultivated and native forage plants; tabulated data for tests of some 500 varieties of wheat, 60 of oats, and 50 of barley; a list with descriptive notes of species of cryptogams collected in Wyoming; meteorological observations; and reprints of Bulletins 41–45 of the station.

GENERAL OUTLOOK.

Animal industry stands at the head of agricultural industries in Wyoming, and the station is planning its work so as to eventually give this branch of agriculture a leading place in its investigations. As yet the station funds are too limited to permit the purchase of live stock needed for investigations, but feeding experiments in cooperation with private persons have been started, and other closely related investigations in irrigation and forage production are being carried on with a view to preparing the way for useful experiments with live stock when funds are provided for its purchase. The station is working earnestly along such lines as its limited funds will permit, and is coming into closer relations with the agricultural and especially the live-stock interests of the State. The carrying on of important investigations with live stock, under the conditions existing in this State, will require considerable additional funds and it is hoped that the State will be able to supplement the national funds for this purpose in the near future. The station should also be put in such financial condition that it can have a director as a separate officer.

STATISTICS OF THE AGRICULTURAL EXPERIMENT STATIONS.

TABLE 1.—*General statistics, 1901.*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist at farmers' institutes.	Publications during fiscal year 1900-1901.		Number of addresses on mailing list.	Principal lines of work.
								No.	Pages.		
Alabama (College)	Auburn	P. H. Mell	Feb. —, 1883	Feb. 24, 1888	13	7	9	7	253	9.200	Botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; diseases of plants; feeding experiments; diseases of animals.
Alabama (Canebrake)	Uniontown	J. M. Richeson	Jan. 1, 1886	Apr. 1, 1888	3	2	......	......	......	2,300	Soil improvement; field experiments; horticulture; floriculture; diseases of plants; diseases of animals.
Alabama (Tuskegee)	Tuskegee	G. W. Carver	Feb. 15, 1897	......	10	6	9	7	66	1,500	Field experiments and feeding experiments.
Arizona	Tucson	R. H. Forbes	......	1889	8	2	4	19	118	4,800	Chemistry; botany; field experiments; improvement of ranges; horticulture, including date-palm culture; feeding experiments.
Arkansas	Fayetteville	R. L. Bennett	......	1887	6	2	......	6	228	6,000	Chemistry of foods; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals.
California	Berkeley	E. W. Hilgard	1875	Mar. —, 1888	22	12	9	6	459	8,100	Physics; chemistry and geographical distribution of soils; bacteriology; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; beet-sugar chemistry; chemistry of foods and feeding stuffs; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; plant introduction.
Colorado	Fort Collins	L. G. Carpenter	1879	Feb. —, 1888	16	8	7	32	422	7,800	Chemistry; field experiments; horticulture; entomology; irrigation.
Connecticut (State)	New Haven	E. H. Jenkins	Oct. 1, 1875	May 18, 1887	15	......	4	4	564	10,253	Analysis and inspection of fertilizers, foods, and feeding stuffs; chemistry; diseases of plants; horticulture; forestry; field experiments; entomology.

Connecticut (Storrs)	Storrs	W. O. Atwater		do	7	2	2	2	244	7,000	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; dairying.
Delaware	Newark	A. T. Neale		Feb. 21, 1888	7	7	7	9	364	7,119	Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Florida	Lake City	T. H. Taliaferro		1888	12	5	4	4	242	4,000	Chemistry; field experiments; horticulture; entomology.
Georgia	Experiment	R. J. Redding	Feb. 18, 1888	July 1, 1889	8	1	....	6	264	9,000	Field experiments; horticulture; entomology; mycology; pig feeding; dairying.
Idaho	Moscow	J. A. McLean		Feb. 26, 1892	11	9	6	6	131	3,500	Physics; botany; field experiments; horticulture; entomology; feeding experiments.
Illinois	Urbana	E. Davenport		Mar. 21, 1888	25	14	12	6	244	18,000	Chemistry; bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; entomology; dairying.
Indiana	Lafayette	C. S. Plumb	1885	Jan. —, 1888	11	7	9	13	202	7,500	Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals.
Iowa	Ames	C. F. Curtiss		Feb. 17, 1888	18	13	6	7	432	20,000	Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying.
Kansas	Manhattan	J. T. Willard		Feb. 8, 1888	14	12	13	34	340	21,158	Soils; horticulture; seed breeding; field experiments; feeding and digestion experiments; diseases of animals; entomology; dairying.
Kentucky	Lexington	M. A. Scovell	Sept. —, 1885	Apr. —, 1888	16	1	5	6	275	7,700	Chemistry; soils; fertilizer analysis; field experiments; horticulture; diseases of plants; entomology; dairying.
Louisiana (Sugar)	New Orleans	W. C. Stubbs	Sept. —, 1885								Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.
Louisiana (State)	Baton Rouge	do	Apr. —, 1886		23	5	5	5	304	15,000	Chemistry; geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments; horticulture; diseases of animals; entomology.
Louisiana (North)	Calhoun	do	May —, 1887								Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying.
Maine	Orono	C. D. Woods	Mar. —, 1885	Oct. 1, 1887	13	6	3	11	428	11,000	Chemistry; botany; analysis and inspection of fertilizers, concentrated commercial feeding stuffs, and creamery glassware; horticulture; diseases of plants; seed tests; food and nutrition of man and animals; poultry raising; marine invertebrates; diseases of animals; entomology; dairying.

TABLE 1.—*General statistics, 1901*—Continued.

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist at farmers' institutes.	Publications during fiscal year 1900–1901. No.	Publications during fiscal year 1900–1901. Pages.	Number of addresses on mailing list.	Principal lines of work.
Maryland	College Park	H. J. Patterson	1888	Apr. —, 1888	15	7	5	10	230	10,500	Chemistry; soils; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
Massachusetts	Amherst	H. H. Goodell	[a] 1882	Mar. 2, 1888	19	8	6	21	385	16,500	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; field experiments; horticulture; electrogermination; diseases of plants; digestion and feeding experiments; diseases of animals; entomology; dairying.
Michigan	Agricultural College.	C. D. Smith	....	Feb. 26, 1888	14	6	9	9	244	30,000	Bacteriology; soils; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; apiculture; stable hygiene.
Minnesota	St. Anthony Park, St. Paul.	W. M. Liggett	Mar. 7, 1885	1888	13	7	....	4	360	12,500	Chemistry; soils; field experiments; horticulture; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying.
Mississippi	Agricultural College.	W. L. Hutchinson	....	Jan. 27, 1888	10	6	7	5	122	15,000	Soils; fertilizers; field experiments; horticulture; animal husbandry; feeding experiments; diseases of animals; entomology; dairying.
Missouri (State)	Columbia	H. J. Waters	....	Jan. —, 1888	12	6	4	.....	.....	12,500	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying; drainage.
Missouri (Fruit)	Mountain Grove	J. T. Stinson	Feb. 1, 1900	....	3	.....	2	1	22	2,000	Horticulture.
Montana	Bozeman	S. Fortier	....	July 1, 1893	9	5	5	7	252	5,345	Chemistry; meteorology; field experiments; horticulture; feeding experiments; poultry experiments; entomology; irrigation.
Nebraska	Lincoln	E. A. Burnett	Dec. 16, 1884	June 13, 1887	18	11	5	6	134	18,500	Chemistry; botany; meteorology; soils; field experiments; horticulture; forestry; feeding and breeding experi-

											ments; diseases of animals; entomology; irrigation.
Nevada	Reno	J. E. Stubbs			9	6	6	6	70	2,100	Chemistry; botany; soils; field experiments; horticulture; forestry; feeding experiments; animal diseases; entomology; irrigation.
New Hampshire	Durham	W. D. Gibbs	1886	Aug. 4, 1887	11	10	7	10	275	10,000	Chemistry; bacteriology; soil physics; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
New Jersey (State)	New Brunswick	E. B. Voorhees	Mar. 10, 1880		11	1	3	5	465	10,000	Chemistry; biology; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments; horticulture; diseases of plants; food and nutrition of man; diseases of animals; entomology; dairy husbandry; bacteria of milk; irrigation.
New Jersey (College)	do	do		Apr. 26, 1888	8	4	3	6	355		
New Mexico	Mesilla Park	Luther Foster		Dec. 14, 1889	9	6		7	231	3,500	Chemistry; soil physics; field experiments; horticulture; entomology; irrigation.
New York (State)	Geneva	W. H. Jordan	Mar. —, 1882		26		10	22	958	40,000	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
New York (Cornell)	Ithaca	I. P. Roberts	1879	Apr. —, 1888	18	7	4	12	518	20,000	Chemistry of soils, feeding stuffs and dairy products; soils; fertilizers; field experiments; horticulture; diseases of plants; feeding sheep and swine; diseases of animals; poultry experiments; entomology; dairying.
North Carolina	Raleigh	B. W. Kilgore	Mar. 12, 1877	Mar. 7, 1887	14	5	4	9	131	16,000	Chemistry; soils; field experiments; horticulture; analysis of feeding stuffs; digestion experiments; animal husbandry; diseases of animals; poultry experiments.
North Dakota	Agricultural College.	J. H. Worst		Mar. —, 1890	8	5	5	5	442	8,400	Field experiments; plant breeding; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying.
Ohio	Wooster	C. E. Thorne	Apr. 25, 1882	Apr. 2, 1888	16		4	7	245	38,000	Soils; field experiments; horticulture; diseases of plants; breeding and feeding experiments; diseases of animals; entomology.
Oklahoma	Stillwater	John Fields		Dec. 25, 1890	9	4	5	5	269	18,785	Field experiments; horticulture; forestry; diseases of plants; digestion and feeding experiments; animal husbandry; diseases of animals; entomology.

[a] In 1882 the State organized a station here and maintained it until June 18, 1895, when it became a part of the Hatch Station at the same place.

TABLE 1.—*General statistics, 1901*—Continued.

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist at farmers' institutes.	Publications during fiscal year 1900–1901.		Number of addresses on mailing list.	Principal lines of work.
								No.	Pages.		
Oregon	Corvallis	J. Withycombe		July —, 1888	11	7	5	6	159	4,250	Chemistry; soils; field crops; horticulture; diseases of plants; digestion and feeding experiments; entomology; dairying.
Pennsylvania	State College	H. P. Armsby		June 30, 1887	17	7	5	4	32	11,500	Chemistry; meteorology; fertilizer analysis; field experiments; feeding experiments; dairying.
Rhode Island	Kingston	H. J. Wheeler		July 30, 1888	10	6		10	389	9,000	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry experiments.
South Carolina	Clemson College	H. S. Hartzog		Jan. —, 1888	15	7	7	11	201	9,000	Soils; analysis and control of fertilizers; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying.
South Dakota	Brookings	J. W. Heston		Mar. 13, 1887	12	6		4	206	9,005	Bacteriology; chemistry of soils and soil physics; field experiments; forestry; plant breeding; diseases of plants; feeding experiments; entomology; irrigation.
Tennessee	Knoxville	A. M. Soule	June 8, 1882	Aug. 4, 1887	11	11	5	5	144	9,500	Chemistry; soils; fertilizers; field experiments; horticulture; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying.
Texas	College Station	J. H. Connell			14	5	6	5	150	13,875	Chemistry; soils; field experiments; horticulture; diseases of animals; irrigation.
Utah	Logan	J. A. Widtsoe		1890	14	9	7	5	276	3,900	Chemistry of soils and feeding stuffs; alkali soil investigations; meteorology; field experiments; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments; dairying; poultry experiments; irrigation.

Vermont	Burlington	J. L. Hills	Nov. 24, 1886	Feb. 28, 1888	12	6	3	8	504	9,700	Chemistry; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; dairying.
Virginia	Blacksburg	J. M. McBryde	1888	1891	11	5	5	10	191	9,000	Field crops; horticulture; feeding experiments; veterinary science; entomology; cider and vinegar making; ferments.
Washington	Pullman	E. A. Bryan	....	1891	10	7	6	6	106	5,000	Chemistry; botany; bacteriology; soils; field experiments; horticulture; diseases of plants; feeding and breeding experiments; oyster culture; diseases of animals; entomology; dairying; irrigation.
West Virginia	Morgantown	J. H. Stewart	....	June 11, 1888	13	4	5	11	396	7,048	Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; inspection of orchards and nurseries; feeding experiments; poultry experiments; entomology.
Wisconsin	Madison	W. A. Henry	1883	1887	19	14	20	8	465	12,000	Chemistry; soils; field experiments; horticulture; feeding experiments; dairying; drainage and irrigation.
Wyoming	Laramie	E. E. Smiley	1887	Mar. 1, 1891	9	6	6	5	600	3,800	Geology; botany; meteorology; waters; soils; fertilizers; field experiments; food analysis; feeding experiments; entomology; irrigation.
Total	....	....	....	....	688	325	288	445	15,107	587,138	

TABLE 2.—*Revenue and additions to equipment in 1901.*

Station.	Hatch fund.	State.	Individuals and communities.	Fees.	Farm products.	Miscellaneous.	Total.	Additions to equipment in 1901. Buildings.	Library.	Apparatus.	Farm implements.	Live stock.	Miscellaneous.	Total.
Alabama (College)	$15,000.00			$8,741.95	$895.37		$24,637.32	$530.51	$500.00	$864.97	$142.08	$44.61	$1,034.02	$3,116.19
Alabama (Canebrake)		$2,500.00			370.36	$1,535.87	4,406.23	224.18	3.50		16.18			243.86
Alabama (Tuskegee)		1,500.00					1,500.00							
Arizona	15,000.00				779.06	322.10	16,101.16	178.65	87.77	263.52	531.11	115.90		1,176.95
Arkansas	15,000.00				1,007.28		16,007.28	122.86	52.18		28.20	132.45		335.69
California	15,000.00	11,543.00			54.79		26,597.79	29.20	269.68	41.50	684.25		32.71	1,057.34
Colorado	15,000.00				1,280.10	624.34	16,904.44	50.49	37.74	433.94	33.65	39.50	441.78	1,037.10
Connecticut (State)	7,500.00	12,500.00	$1,580.59	7,730.40	911.85	139.91	30,362.75		539.88	59.18			716.67	1,315.73
Connecticut (Storrs)	7,500.00	1,800.00			115.70	12.50	9,428.20	9.15		495.15		25.15	86.90	616.35
Delaware	15,000.00						15,000.00	106.05	593.00	460.58	25.80	16.51	1,230.89	2,432.83
Florida	15,000.00				863.67		15,863.67	725.00	83.40	486.76	312.27	846.42		2,453.85
Georgia	15,000.00	750.00			2,361.48	2,935.71	21,047.19	1,030.00			50.00	50.00		1,130.00
Idaho	15,000.00				1,500.00		16,500.00	1,025.00	73.59	119.93	113.06	756.15		2,087.73
Illinois	15,000.00			350.00	344.93	663.46	16,358.39	125.17	382.31	196.64	1,136.27	135.01	338.50	2,313.90
Indiana	15,000.00				2,032.67		17,032.67		93.92	37.90	422.11	53.10		607.03
Iowa	15,000.00			5.00	2,951.41	115.34	18,072.05	93.68	15.62	539.39	243.47	534.85	109.13	1,536.14
Kansas	15,000.00				5,345.21	610.69	20,955.90		174.21	450.00	105.00		150.00	879.21
Kentucky	15,000.00	[a]3,123.87		[a]33,054.29	[a]4,372.31	[a]110.76	55,661.23	3,238.73	746.45	220.25	666.39	1,053.68	14,199.30	20,124.80
Louisiana	15,000.00	18,000.00		2,350.03	1,481.73	9,435.75	46,267.51	709.77	227.28	44.90	558.67	282.20	1,344.20	3,167.02
Maine	15,000.00			[b]4,526.10	2,714.36	103.62	22,344.08	1,100.89	141.15	291.83	160.48	217.20		1,911.55
Maryland	15,000.00				4,440.08	98.72	19,538.80	263.97	130.22	68.70	381.78	245.00		1,089.67
Massachusetts	15,000.00	11,200.00		3,490.25	2,091.08	2,050.50	33,831.83		221.31	5.49		20.25	75.59	322.64
Michigan	15,000.00	4,507.29		1,960.00	1,516.07	733.54	23,716.90	15,000.00	332.54	720.20	35.71	1,259.41		17,347.86
Minnesota	15,000.00	[c]35,956.32			[b]7,246.14		58,202.46		13.16		207.69	4,333.17		4,554.02
Mississippi	15,000.00				632.74	924.24	16,556.98				300.00	300.00	200.00	800.00
Missouri (State)	15,000.00			1,373.30	2,676.99	2,731.40	21,781.69		150.00	300.00	35.00	1,100.00		1,585.00
Missouri (Fruit)		26,525.00					26,525.00	10,000.00	400.00	500.00	550.00	300.00		11,750.00
Montana	15,000.00	200.00			3,549.04		18,749.04	320.68	116.25	277.18	422.10	150.00		1,286.21
Nebraska	15,000.00				1,205.77	689.01	16,894.78	574.16	226.66	442.26	201.28	66.75	514.84	2,025.95
Nevada	15,000.00				430.65	572.88	16,003.53	560.00	120.30	428.49	113.00		674.52	1,896.31
New Hampshire	15,000.00			483.36			15,483.36	175.59	196.95	72.86	45.40			490.80
New Jersey (State)		19,000.00					19,000.00		107.24	254.04		200.00	873.72	1,435.00
New Jersey (College)	15,000.00						15,000.00	279.49	660.16	426.62	7.75	35.00	177.99	1,587.01
New Mexico	15,000.00			5.30	466.51		15,471.81	750.00	80.15	287.07	756.22	281.20	356.83	2,511.47
New York (State)	1,500.00	87,119.82					88,619.82	11,500.00	690.21	151.50	200.00			12,541.71
New York (Cornell)	13,500.00	[d]12,131.69			[a]397.87		26,029.56		66.79	248.86	21.58	19.50	106.33	463.06
North Carolina	15,000.00				434.01	262.38	15,696.39	528.09	620.26	350.00	212.56	261.35		1,972.26
North Dakota	15,000.00				1,317.04	598.00	16,915.04	14,000.00	15,000.00	360.00	750.00		500.00	30,610.00
Ohio	15,000.00	13,600.00		263.64	6,560.23	15,191.30	50,615.17	4,494.04	467.90	167.47	48.80	659.05	224.62	6,061.88
Oklahoma	15,000.00				[a]2,924.84		17,924.84	1,142.63	134.38	30.07	334.88	450.00	338.00	2,429.96
Oregon	15,000.00				[a]3,044.02		18,044.02	207.90	194.89	212.08	244.59	428.45		1,287.91

Pennsylvania	15,000.00	....	....	8,355.00	4,723.97	95.46	28,174.43	191.93	218.15	1,613.92	54.40	110.00	42.25	2,230.65
Rhode Island	15,000.00	....	....	....	568.45	208.96	15,777.41	77.99	500.75	209.31	100.00	46.05	53.16	987.26
South Carolina	15,000.00	....	....	....	783.26	....	15,783.26	668.38	268.03	565.67	81.93	67.30	....	1,651.31
South Dakota	15,000.00	1,000.00	....	....	817.74	500.00	17,317.74	....	....	....	415.65	....	....	415.65
Tennessee	15,000.00	....	....	....	3,709.11	....	18,709.11	388.33	193.64	182.16	499.47	850.00	1.25	2,114.85
Texas	15,000.00	2,500.00	....	....	....	691.47	18,191.47	420.47	195.36	436.09	306.03	....	423.63	1,781.58
Utah	15,000.00	....	....	....	4,054.08	727.77	19,781.85	295.24	60.44	136.50	338.16	248.45	131.32	1,210.11
Vermont	15,000.00	....	....	3,446.28	5,542.46	....	23,988.74	737.70	158.31	170.54	235.92	953.00	....	2,255.47
Virginia	15,000.00	....	....	....	3,994.51	....	18,994.51	....	....	240.00	....	50.00	....	290.00
Washington	15,000.00	9,848.96	....	....	....	565.98	25,414.94	56,403.00	1.67	787.46	270.08	181.05	399.20	58,042.46
West Virginia	15,000.00	....	....	6,062.50	326.84	1,056.67	22,446.01	1,741.85	275.15	53.09	51.52	465.08	....	2,586.69
Wisconsin	15,000.00	[e]15,000.00	....	125.00	....	....	30,125.00	2,800.00	371.12	334.16	405.58	570.00	....	4,480.86
Wyoming	15,000.00	....	....	....	528.20	....	15,528.20	600.00	109.82	271.25	229.38	267.50	247.75	1,725.70
Total	720,000.00	290,305.95	1,580.59	82,322.40	93,363.98	44,308.63	1,231,881.55	133,420.77	26,303.49	15,309.48	13,085.45	18,220.29	25,025.10	231,364.58

[a] Including balance. [b] For calendar year 1900. [c] Including subexperiment farms. [d] Estimated amount of State appropriation spent for experimental purposes.
[e] Estimated amount of State appropriation for the college of agriculture and experiment station spent for experimental purposes.

TABLE 3.—*Expenditures from United States appropriation for year ended June 30, 1901.*[a]

Station.	Amount.	Itemized. Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.	Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Building and repairs.	Balance.
Alabama	$15,000.00	$9,072.35	$1,266.49	$1,138.39	......	$346.61	$216.44	$584.95	$870.41	$315.80	$215.56	$500.00	$142.08	......	$177.52	$44.11	$95.29	$14.00	......	......
Arizona	15,000.00	7,527.55	3,556.10	797.16	$211.57	244.24	107.05	173.04	220.72	309.69	121.13	2.84	480.22	$49.20	202.07	8.45	548.40	22.50	$418.07	......
Arkansas	15,000.00	9,903.80	1,533.14	628.05	204.79	138.22	30.13	118.71	990.89	......	57.54	52.18	28.20	50.65	......	132.45	649.35	93.00	388.90	......
California	15,000.00	7,318.26	4,598.82	118.68	193.55	145.03	244.20	183.37	464.03	......	109.00	219.68	531.90	188.00	41.50	......	559.90	42.50	41.58	......
Colorado	15,000.00	10,773.53	691.20	1,546.99	335.17	16.82	......	6.43	169.42	156.00	10.60	37.74	19.15	108.45	84.92	39.50	944.59	10.00	50.49	......
Connecticut (State)	7,500.00	7,500.00	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Connecticut (Storrs)	7,500.00	4,091.08	1,057.53	76.78	336.13	96.45	627.36	220.98	190.20	64.23	133.34	......	5.05	59.20	355.89	25.15	141.48	10.00	9.15	......
Delaware	15,000.00	9,508.33	1,111.67	1,222.48	242.23	149.78	268.80	65.63	326.58	7.00	56.32	597.13	7.50	169.68	481.49	16.51	570.42	92.40	106.05	......
Florida	15,000.00	5,102.59	3,156.87	1,040.91	294.34	240.37	124.17	70.60	570.61	374.19	788.18	83.40	312.27	57.50	486.72	846.42	708.86	10.00	732.00	......
Georgia	15,000.00	7,605.00	2,257.78	1,865.31	213.35	207.04	166.38	......	645.90	427.19	286.49	92.23	123.48	78.45	114.52	......	168.17	16.00	732.71	......
Idaho	15,000.00	7,207.32	3,244.95	695.62	23.95	124.60	702.33	210.19	90.34	......	291.03	73.59	113.06	212.77	119.93	756.15	332.52	51.65	750.00	......
Illinois	15,000.00	6,452.61	2,857.22	1,351.47	421.21	131.72	......	139.34	395.97	......	321.84	382.31	1,136.27	338.50	196.64	135.01	531.75	82.97	125.17	......
Indiana	15,000.00	9,086.97	1,919.14	812.10	106.21	122.20	656.72	45.24	700.39	8.63	793.38	100.55	350.08	11.00	6.09	140.00	49.65	11.77	79.88	......
Iowa	15,000.00	7,491.82	2,210.36	1,127.75	454.73	361.98	511.92	221.23	505.73	......	536.11	15.62	243.47	109.13	539.39	534.85	32.23	10.00	93.68	......
Kansas	15,000.00	8,516.54	2,645.58	438.35	169.50	137.49	11.00	111.88	258.31	......	160.71	134.65	144.17	153.33	353.41	1,446.85	62.21	10.00	246.02	......
Kentucky	15,000.00	10,742.68	1,666.22	667.20	137.10	69.46	85.26	174.66	170.45	......	......	746.45	92.95	......	220.25	......	131.25	96.07	......	......
Louisiana	15,000.00	7,181.28	2,879.75	1,768.85	379.51	295.85	306.97	484.36	286.46	101.66	355.88	227.78	404.55	......	44.90	282.20	......	......	......	......
Maine	15,000.00	7,902.34	1,756.75	286.77	275.01	219.48	801.54	441.42	398.40	128.33	991.27	141.15	160.48	99.08	291.83	446.03	289.23	......	370.89	......
Maryland	15,000.00	7,533.44	2,765.79	1,461.37	134.84	284.18	372.89	91.20	468.46	79.09	462.37	130.22	......	226.67	68.70	245.00	247.46	10.00	418.32	......
Massachusetts	15,000.00	8,157.57	2,941.04	1,436.30	269.33	99.82	259.63	......	621.30	182.21	135.08	221.31	52.58	75.59	5.49	20.25	84.39	147.52	290.59	......
Michigan	15,000.00	8,363.90	2,112.28	528.46	330.01	181.05	......	139.57	380.09	27.65	135.17	332.54	35.71	115.50	720.20	1,259.41	203.06	......	135.40	......
Minnesota	15,000.00	11,373.33	1,234.45	......	29.00	......	912.78	......	350.15	......	380.44	5.00	157.08	18.00	......	25.00	204.77	199.80	110.20	......
Mississippi	15,000.00	8,412.15	1,637.97	588.36	159.52	161.01	242.20	232.52	751.29	16.94	899.45	17.85	264.43	30.00	30.00	608.26	191.45	10.00	746.60	......
Missouri	15,000.00	6,942.86	2,462.52	441.80	207.34	142.12	182.60	155.63	443.62	13.00	1,759.00	190.83	84.64	50.15	84.51	1,169.36	226.41	10.00	433.61	......
Montana	15,000.00	8,129.38	3,000.00	1,518.31	171.62	286.37	266.45	89.82	477.05	9.50	73.47	116.25	422.10	162.50	277.18	......	......	......	......	......
Nebraska	15,000.00	8,252.89	2,621.65	683.81	499.94	129.51	......	116.42	646.03	5.00	150.00	226.66	201.28	91.60	442.26	66.75	265.89	26.15	574.16	......
Nevada	15,000.00	9,299.30	2,786.50	1,021.19	106.95	117.10	150.60	39.70	388.79	......	......	20.30	3.00	59.80	1.35	......	317.55	14.50	673.37	......
New Hampshire	15,000.00	9,843.57	1,572.83	1,144.13	73.15	69.28	989.29	45.31	343.28	33.88	......	196.95	52.80	4.68	47.09	......	100.02	28.46	455.28	......
New Jersey	15,000.00	9,460.00	1,146.52	1,176.41	212.48	70.77	309.94	83.39	125.64	65.90	267.01	660.16	7.75	14.97	426.62	35.00	313.19	166.77	457.48	......
New Mexico	15,000.00	7,500.00	2,040.29	565.83	408.77	243.97	62.65	57.06	304.28	45.00	450.70	80.15	756.22	356.83	287.07	281.20	489.94	320.00	750.00	......
New York (State)	1,500.00	......	......	803.15	.50	......	21.89	33.50	147.17	......	82.09	62.09	......	75.00	69.44	......	126.04	79.13	......	......
New York (Cornell)	13,500.00	8,936.77	1,199.43	1,468.23	482.29	90.24	74.25	101.46	491.35	6.75	42.83	66.79	21.58	106.33	248.86	19.50	117.15	25.00	1.19	......

North Carolina	15,000.00	9,720.00	1,673.57	265.85	68.00	8.15	13.07	291.40	196.09	211.73	392.39	620.26	247.01	60.51	350.00	261.35	75.97	10.00	534.65	
North Dakota	15,000.00	5,316.52	6,931.18	1,187.58	137.90	43.26	146.80		252.83		775.61		65.32				125.00	18.00		
Ohio	15,000.00	12,362.32	1,126.93	60.84	132.37		71.50		455.22	96.52	283.34	165.25	119.12		33.75			10.00	82.84	
Oklahoma	15,000.00	5,430.00	2,496.85	2,046.64	426.54	215.41	472.06	328.70	274.08		605.99	134.38	308.98	549.86	30.07	450.00	452.44	28.00	750.00	
Oregon	15,000.00	9,031.00	2,055.18	212.92	71.32	203.89		724.36	1,139.69	37.50	293.95	194.89	244.59	13.65	212.08	251.85		74.96	238.17	
Pennsylvania	15,000.00	10,409.35	839.60	884.98	181.76		25.37	368.92	56.25	50.13	730.50	5.00	58.54		766.28	128.02	299.22	14.67	181.41	
Rhode Island	15,000.00	8,876.93	2,788.15	40.74	220.48	161.37	320.57	90.81	531.91	180.87	479.94	499.62	106.95	39.37	209.31	44.70	268.33	19.31	120.64	
South Carolina	15,000.00	7,788.95	2,315.56	953.22	106.48	201.56		465.72	1,057.41	91.33	272.06	268.03	81.93	52.87	99.95	67.30	431.49	15.89	730.25	
South Dakota	15,000.00	9,324.39	1,667.13	1,224.95	243.38	206.08		280.51	156.34		80.43	18.90	437.53	74.97	636.38		99.44	20.00	29.57	$500.00
Tennessee	15,000.00	6,643.33	4,067.26	805.87	299.03	38.50	395.22	151.56	279.33	99.70	556.89	193.64	499.47	1.25	182.16	75.38	398.65	173.41	139.35	
Texas	15,000.00	8,862.28	1,291.35	866.59	376.88	234.92	44.52	238.77	606.75	42.43	192.20	195.36	310.32	423.63	436.09	8.00	328.15		541.76	
Utah	15,000.00	5,898.80	4,091.89	1,640.15	268.49	204.31	240.92	202.27	252.29	53.75	875.17	60.44	338.16	131.32	136.50	248.45	51.85	10.00	295.24	
Vermont	15,000.00	6,882.60	2,459.48	890.05	533.57	125.14	366.80	323.70	189.77	98.71	1,579.07	158.31	28.64	168.45	170.54	50.00	452.82	19.70	502.65	
Virginia	15,000.00	8,871.08	2,666.00	1,361.24	32.25	240.96	238.39	161.97	409.74	226.13	428.80		6.04		240.40	50.00	21.60	10.00	35.40	
Washington	15,000.00	7,229.16	3,385.56	227.08	215.27	329.18	1,168.70	43.94	384.14		210.35	1.67	275.95	3.67	399.39	181.05	541.90		402.99	
West Virginia	15,000.00	10,064.85	918.27		91.10	148.77	717.52	323.49	383.23	103.22	487.86	261.15	51.52	17.75	53.09	465.08	270.97	10.00	601.85	30.28
Wisconsin	15,000.00	10,815.00	2,784.81		82.96		10.25	18.53	527.35	25.00	54.08	283.44	309.55		39.80	3.00	36.23	10.00		
Wyoming	15,000.00	3,703.35	4,341.86	1,765.72	622.10	279.89	806.97	191.35	530.34	1.00	187.73	109.82	229.38	247.75	271.25	267.50	683.99	10.00	750.00	

[a] The expenditures under different heads are affected by the total revenue of the station, as shown in Table 2.

FEDERAL LEGISLATION, REGULATIONS, AND RULINGS AFFECTING AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

FEDERAL LEGISLATION.

Act of 1862 Donating Lands for Agricultural Colleges.

AN ACT donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be granted to the several States, for the purposes hereinafter mentioned, an amount of public land, to be apportioned to each State a quantity equal to thirty thousand acres for each Senator and Representative in Congress to which the States are respectively entitled by the apportionment under the census of eighteen hundred and sixty: *Provided,* That no mineral lands shall be selected or purchased under the provisions of this act.

Sec. 2. That the land aforesaid, after being surveyed, shall be apportioned to the several States in sections or subdivisions of sections, not less than one quarter of a section; and whenever there are public lands in a State subject to sale at private entry at one dollar and twenty-five cents per acre, the quantity to which said State shall be entitled shall be selected from such lands within the limits of such State, and the Secretary of the Interior is hereby directed to issue to each of the States in which there is not the quantity of public lands subject to sale at private entry at one dollar and twenty-five cents per acre to which said State may be entitled under the provisions of this act land scrip to the amount in acres for the deficiency of its distributive share; said scrip to be sold by said States and the proceeds thereof applied to the uses and purposes prescribed in this act and for no other use or purpose whatsoever: *Provided,* That in no case shall any State to which land scrip may thus be issued be allowed to locate the same within the limits of any other State or of any Territory of the United States, but their assignees may thus locate said land scrip upon any of the unappropriated lands of the United States subject to sale at private entry at one dollar and twenty-five cents, or less, per acre: *And provided further,* That not more than one million acres shall be located by such assignees in any one of the States: *And provided further,* That no such location shall be made before one year from the passage of this act.

Sec. 3. That all the expenses of management, superintendence, and taxes from date of selection of said lands, previous to their sales, and all expenses incurred in the management and disbursement of the moneys which may be received therefrom, shall be paid by the States to which they may belong, out of the treasury of said States, so that the entire proceeds of the sale of said lands shall be applied without any diminution whatever to the purposes hereinafter mentioned.

Sec. 4. That all moneys derived from the sale of the lands aforesaid by the States to which the lands are apportioned, and from the sales of land scrip hereinbefore provided for, shall be invested in stocks of the United States, or of the States, or some other safe stocks, yielding not less than five per centum upon the par value of said stocks; and that the moneys so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished (except so far as may be provided

in section fifth of this act), and the interest of which shall be inviolably appropriated, by each State which may take and claim the benefit of this act, to the endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.

Sec. 5. That the grant of land and land scrip hereby authorized shall be made on the following conditions, to which, as well as to the provisions hereinbefore contained, the previous assent of the several States shall be signified by legislative acts:

First. If any portion of the fund invested, as provided by the foregoing section, or any portion of the interest thereon, shall, by any action or contingency, be diminished or lost, it shall be replaced by the State to which it belongs, so that the capital of the fund shall remain forever undiminished; and the annual interest shall be regularly applied without diminution to the purposes mentioned in the fourth section of this act, except that a sum, not exceeding 10 per centum upon the amount received by any State under the provisions of this act, may be expended for the purchase of lands for sites or experimental farms, whenever authorized by the respective legislatures of said States.

Second. No portion of said fund, nor the interest thereon, shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings.

Third. Any State which may take and claim the benefit of the provisions of this act shall provide, within five years, at least not less than one college, as described in the fourth section of this act, or the grant to such State shall cease; and said State shall be bound to pay the United States the amount received of any lands previously sold, and that the title to purchasers under the State shall be valid.

Fourth. An annual report shall be made regarding the progress of each college, recording any improvements and experiments made; with their cost and results, and such other matters, including State industrial and economical statistics, as may be supposed useful, one copy of which shall be transmitted by mail free, by each, to all the other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior.

Fifth. When lands shall be selected from those which have been raised to double the minimum price, in consequence of railroad grants, they shall be computed to the State at the maximum price and the number of acres proportionately diminished.

Sixth. No State while in a condition of rebellion or insurrection against the Government of the United States shall be entitled to the benefit of this act.

Seventh. No State shall be entitled to the benefits of this act unless it shall express its acceptance thereof by its legislature within two years from the date of its approval by the President.

Sec. 6. That land scrip issued under the provisions of this act shall not be subject to location until after the first day of January, one thousand eight hundred and sixty-three.

Sec. 7. That the land officers shall receive the same fees for locating land scrip issued under the provisions of this act as is now allowed for the location of military bounty land warrants under existing laws: *Provided*, Their maximum compensation shall not be thereby increased.

Sec. 8. That the governors of the several States to which scrip shall be issued under this act shall be required to report annually to Congress all sales made of such scrip until the whole shall be disposed of, the amount received for the same, and what appropriation has been made of the proceeds.

Approved, July 2, 1862.

Act of 1866 Extending the Time Within Which Agricultural Colleges May be Established.

AN ACT to amend the fifth section of an act entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," approved July 2, 1862, so as to extend the time within which the provisions of said act shall be accepted and such colleges established.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the time in which the several States may comply with the provisions of the act of July two, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," is hereby extended so that the acceptance of the benefits of the said act may be expressed within three years from the passage of this act, and the colleges required by the said act may be provided within five years from the date of the filing of such acceptance with the Commissioner of the General Land Office: *Provided,* That when any Territory shall become a State and be admitted into the Union, such new State shall be entitled to the benefits of the said act of July two, eighteen hundred and sixty-two, by expressing the acceptance therein required within three years from the date of its admission into the Union, and providing the college or colleges within five years after such acceptance, as prescribed in this act: *Provided further,* That any State which has heretofore expressed its acceptance of the act herein referred to shall have the period of five years within which to provide at least one college, as described in the fourth section of said act, after the time for providing said college, according to the act of July second, eighteen hundred and sixty-two, shall have expired.

Approved, July 23, 1866.

Act of 1887 Establishing Agricultural Experiment Stations.

AN ACT to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and the acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *Provided,* That in any State or Territory in which two such colleges have been or may be so established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the legislature of such State or Territory shall otherwise direct.

Sec. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies of the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and

value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories.

Sec. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner [now Secretary] of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purpose of this act. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner [now Secretary] of Agriculture, and to the Secretary of the Treasury of the United States.

Sec. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

Sec. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

Sec. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

Sec. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

Sec. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such State shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any State shall have established under the provisions of said act of July second, aforesaid, an agricultural

department or experimental station, in connection with any university, college, or institution not distinctly an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made to such separate agricultural college or school, and no legislature shall by contract, express or implied, disable itself from so doing.

Sec. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

Sec. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this act.

Approved, March 2, 1887.

Act of 1890 for the Further Endowment of Agricultural Colleges.

AN ACT to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts established under the provisions of an act of Congress approved July second, eighteen hundred and sixty-two.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, arising from the sales of public lands, to be paid as hereinafter provided, to each State and Territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of Congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be twenty-five thousand dollars, to be applied only to instruction in agriculture, the mechanic arts, the English lauguage, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life and to the facilities for such instruction: *Provided*, That no money shall be paid out under this act to any State or Territory for the support and maintenance of a college where a distinction of race or color is made in the admission of students, but the establishment and maintenance of such college separately for white and colored students shall be held to be a compliance with the provisions of this act if the funds received in such State or Territory be equitably divided as hereinafter set forth: *Provided*, That in any State in which there has been one college established in pursuance of the act of July second, eighteen hundred and sixty-two, and also in which an educational institution of like character has been established, or may be hereafter established, and is now aided by such State from its own revenue, for the education of colored students in agriculture and the mechanic arts, however named or styled, or whether or not it has received money heretofore under the act to which this act is an amendment, the legislature of such State may propose and report to the Secretary of the Interior a just and equitable division of the fund to be received under this act, between one college for white students and one institution for colored students, established as aforesaid, which shall be divided into

two parts, and paid accordingly, and thereupon such institution for colored students shall be entitled to the benefits of this act and subject to its provisions, as much as it would have been if it had been included under the act of eighteen hundred and sixty-two, and the fulfillment of the foregoing provisions shall be taken as a compliance with the provisions in reference to separate colleges for white and colored students.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of colleges shall be annually paid on or before the thirty-first day of July of each year, by the Secretary of the Treasury, upon the warrant of the Secretary of the Interior, out of the Treasury of the United States, to the State or Territorial treasurer, or to such officer as shall be designated by the laws of such State or Territory to receive the same, who shall, upon the order of the trustees of the college, or the institution for colored students, immediately pay over said sums to the treasurers of the respective colleges or other institutions entitled to receive the same, and such treasurers shall be required to report to the Secretary of Agriculture and to the Secretary of the Interior, on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement. The grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of the State or Territory for the further and more complete endowment, support, and maintenance of colleges, or of institutions for colored students, as provided in this act, shall, by any action or contingency, be diminished or lost, or be misapplied, it shall be replaced by the State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings. An annual report by the president of each of said colleges shall be made to the Secretary of Agriculture, as well as to the Secretary of the Interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations attached to said colleges, with their cost and results, and such other industrial and economical statistics as may be regarded as useful, one copy of which shall be transmitted by mail free to all other colleges further endowed under this act.

SEC. 4. That on or before the first day of July in each year, after the passage of this act, the Secretary of the Interior shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is entitled to receive its share of the annual appropriation for colleges, or of institutions for colored students, under this act, and the amount which thereupon each is entitled, respectively, to receive. If the Secretary of the Interior shall withhold a certificate from any State or Territory of its appropriation, the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the close of the next Congress, in order that the State or Territory may, if it should so desire, appeal to Congress from the determination of the Secretary of the Interior. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury. And the Secretary of the Interior is hereby charged with the proper administration of this law.

SEC. 5. That the Secretary of the Interior shall annually report to Congress the dis-

bursements which have been made in all the States and Territories, and also whether the appropriation of any State or Territory has been withheld, and if so, the reasons therefor.

Sec. 6. Congress may at any time amend, suspend, or repeal any or all of the provisions of this act.

Approved, August 30, 1890.

Extracts from an Act Making Appropriations for the Department of Agriculture for the Fiscal Year ending June 30, 1901.

Agricultural Experiment Stations: To carry into effect the provisions of an act approved March second, eighteen hundred and eighty-seven, entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto," and to enforce the execution thereof, seven hundred and eighty thousand dollars, thirty-three thousand dollars of which sum shall be payable upon the order of the Secretary of Agriculture, to enable him to carry out the provisions of section three of said act of March second, eighteen hundred and eighty-seven, and twelve thousand dollars of which sum may be expended by the Secretary of Agriculture to investigate and report to Congress upon the agricultural resources and capabilities of Alaska; and to establish and maintain agricultural experiment stations in said Territory, including the erection of buildings and all other expenses essential to the maintenance of such stations, of which sum five thousand dollars shall be immediately available; and the Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of said act of March second, eighteen hundred and eighty-seven; shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress; and the Secretary of Agriculture is hereby authorized to employ such assistants, clerks, and other persons as he may deem necessary, in the city of Washington and elsewhere, and to incur such other expenses for office fixtures and supplies, stationery, traveling, freight, and express charges, illustration of the Experiment Station Record, bulletins, and reports as he may find essential in carrying out the objects of the above acts, and the sums apportioned to the several States shall be paid quarterly in advance.

And the Secretary of Agriculture is hereby authorized to furnish to such institutions or individuals as may care to buy them, copies of the card index of agricultural literature prepared by the Office of Experiment Stations, and charge for the same a price covering the additional expense involved in the preparation of these copies, and he is hereby authorized to apply the moneys received toward the expense of the preparation of the index.

And the Secretary of Agriculture is hereby authorized to expend ten thousand dollars of which sum to establish and maintain an agricultural station in the Hawaiian Islands, including the erection of buildings, the printing (in the Hawaiian Islands), illustration, and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station, which sum shall be immediately available.

And the Secretary of Agriculture is hereby authorized to expend five thousand dollars of which sum to investigate and report to Congress on the agricultural resources and capabilities of Porto Rico, with special reference to the selection of locations for agricultural experiment stations, and the determination of the character and extent of agricultural experiments immediately demanded by the condition of agriculture in that island, and to prepare, print, publish, and distribute in Porto Rico circulars of inquiry and bulletins of information in the English and Spanish languages, which sum shall be immediately available; in all, seven hundred and eighty thousand dollars. * * *

Nutrition Investigations: To enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food, with special suggestions of full, wholesome, and edible rations, less wasteful and more economical than those in common use, seventeen thousand five hundred dollars; and the agricultural experiment stations are hereby authorized to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories, and as may be mutually agreed upon; and the Secretary of Agriculture is hereby authorized to require said stations to report to him the results of any such investigations which they may carry out, whether in cooperation with said Secretary of Agriculture or otherwise.

Irrigation Investigations: To enable the Secretary of Agriculture to investigate and report upon the laws and institutions relating to irrigation and upon the use of irrigation waters, with special suggestions of better methods for the utilization of irrigation waters in agriculture than those in common use, and for the preparation, printing, and illustration of reports and bulletins on irrigation; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories as may be mutually agreed upon; fifty thousand dollars.

Public Road Inquiries: To enable the Secretary of Agriculture to make inquiries in regard to the system of road management throughout the United States; to make investigations in regard to the best methods of road making, and the best kind of road-making materials in the several States; the employment of local and special agents, clerks, assistants, and other labor required in conducting experiments in the city of Washington and elsewhere and in collating, digesting, reporting, and illustrating the results of such experiments; for labor, traveling, and other necessary expenses, and for preparing and publishing bulletins and reports on this subject for distribution, and to enable him to assist the agricultural colleges and experiment stations in disseminating information on this subject, fourteen thousand dollars. * * *

Grass and Forage-Plant Investigation and Animal Foods, Division of Agrostology: * * * The agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in establishing and maintaining experimental grass stations, for determining the best methods of caring for and improving meadows and grazing lands, the use of different grasses and forage plants, and their adaptability to various soils and climates, the best native and foreign species for reclaiming overstocked ranges and pastures, for renovating worn-out lands, for binding drifting sands and washed lands, and for turfing lawns and pleasure grounds, and for solving the various forage problems presented in the several sections of our country, seventeen thousand dollars: *Provided*, That six thousand dollars of the amount hereby appropriated be used to purchase and collect seeds, roots, and specimens of valuable and economic grasses and forage plants, to be distributed to the various experiment stations in the several States and Territories, to be by them used, under the direction of the Secretary of Agriculture, to ascertain their adaptability to the various soils and climates of the United States. * * *

Purchase and Distribution of Valuable Seeds: For the purchase, propagation, and distribution of valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants; the employment of local and special agents, clerks, assistants, and other labor required in the city of Washington and elsewhere; transportation, paper, twine, gum, printing, postal cards, and all necessary material and repairs for putting up and distributing the same, and to be distributed in localities adapted to their culture, one hundred and seventy thousand dollars: * * * *Provided further*, That twenty

thousand dollars of the sum thus appropriated, or so much thereof as the Secretary of Agriculture shall direct, may be used to collect, purchase, test, propagate, and distribute rare and valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants from foreign countries for experiments with reference to their introduction into this country; and the seeds, bulbs, trees, shrubs, vines, cuttings, and plants thus collected, purchased, tested, and propagated shall not be included in general distribution, but shall be used for experimental tests, to be carried on with the cooperation of the agricultural experiment stations.

REGULATIONS OF THE POST-OFFICE DEPARTMENT CONCERNING AGRICULTURAL EXPERIMENT STATION PUBLICATIONS.

Section 372 of the Postal Laws and Regulations of the United States reads as follows: Regulations for free transmission of bulletins and reports [under the act of Congress of March 2, 1887, are prescribed as follows:

(1) Any claimant of the privilege must apply for authority to exercise it to the Postmaster-General, stating the date of the establishment of such station, its proper name or designation, its official organization, and the names of its officers; the name of the university, college, school, or institution to which it is attached, if any, the legislation of the State or Territory providing for its establishment, and any other granting it the benefits of the provision made by Congress as aforesaid (accompanied by a copy of the act or acts), and whether any other such station in the same State or Territory is considered, or claims to be, also entitled to the privilege; and also the place of its location and the name of the post-office where the bulletins and reports will be mailed. The application must be signed by the officer in charge of the station.

(2) If such application be allowed after examination by the Department, the postmaster at the proper office will be instructed to admit such bulletins and reports to the mails in compliance with these regulations, and the officer in charge of the station will be notified thereof.

(3) Only such bulletins or reports as shall have been issued after the station became entitled to the benefits of the act can be transmitted free, and such bulletins or reports may be inclosed in envelopes or wrappers, sealed or unsealed. On the exterior of every envelope, wrapper, or package must be written or printed the uame of the station and place of its location, the designation of the inclosed bulletin or report, and the word "Free" over the signature, or facsimile thereof, of the officer in charge of the station, to be affixed by himself or by some one duly deputed by him for that purpose. There may also be written or printed upon the envelope or wrapper a request that the postmaster at the office of delivery will notify the mailing station of the change of address of the addressee, or other reason for inability to deliver the same, and upon a bulk package a request to the postmaster to open and distribute the "franked" matter therein in accordance with the address thereon.

Bulletins published by the United States Department of Agriculture and analogous to those of the station, and entitled to be mailed free under the penalty envelope of that Department, may also be adopted and mailed by the several stations, with their own publications, under the same regulations, and any bulletins or reports mailable free by any agricultural experiment station under these regulations may be so mailed by any other station having free-mailing authority.

If such station's annual reports be printed by State authority, and consist in part of matter relating to the land-grant college to which such station is attached, then said report may be mailed free entire by the director of the station; provided, in his judgment, the whole consists of useful information of an agricultural character.

(4) The bulletins may be mailed to the stations, newspapers, or persons to whom they are by the foregoing act authorized to be sent, and the annual reports to any

address within the United States, Canada, Mexico, or Hawaiian Kingdom (Sandwich Islands), but not to other foreign countries, free of postage.

An order of the Postmaster-General dated January 3, 1899, provides "That any article entitled to transmission free of postage in the domestic mails of the United States, either in a 'penalty' envelope or under a duly authorized 'frank,' shall be entitled likewise to transmission by mail free of postage between places in Hawaii, Cuba, Porto Rico, and the Philippine Islands; from the United States to those islands, and from those islands to the United States."

Among rulings on matters of detail the following are the most important:

"In sending out bulletins from an agricultural experiment station it is permissible to inclose postal cards to enable correspondents of the station to acknowledge the receipt of its publications and to request their continuous transmission.

"Copies of the reports or bulletins of the agricultural experiment stations, which are purchased, paid, or subscribed for, or otherwise disposed of for gain, when sent in the mails, are not entitled to free carriage under the 'frank' of the director of the station."

Station bulletins and reports, consisting of typewritten matter duplicated on a mimeograph or other duplicating machine, "retain their character as free matter when properly franked by the director of the station."

Reports of State boards of agriculture or other State boards, commissioners, or officers, even though they contain station bulletins and reports, can not be sent free through the mails under the frank of the director of the station.

The catalogue of the college of which the station is a department can not be sent free through the mails under the frank of the director of the station, whether said catalogue is published separately or is bound together with a station publication.

RULINGS OF THE TREASURY DEPARTMENT AFFECTING AGRICULTURAL EXPERIMENT STATIONS.

From copies of letters addressed to the Secretary of the Treasury and others by the First Comptroller of the Treasury, relating to the construction of the act of Congress of March 2, 1887, and acts supplementary thereto, the following digest has been prepared for the use of the stations. The sections are those of the act, the dates those of the decisions by the Comptroller:

SECTION 3—JANUARY 30, 1888.

That the annual financial statement of the stations, with vouchers, should not be sent to the Treasury Department, but that a copy simply of the report that is made to the governor is to be sent to the Secretary of the Treasury.

SECTION 3—JANUARY 31, 1888.

First. That the Treasury Department will not require officers of experiment stations to do or perform anything not specifically required by said bill.

Second. That the Secretary of the Treasury is not required to take a bond of the officers of said stations for the money paid over under the provisions of said act.

Third. That no reports will be required from the stations directly to the Secretary of the Treasury; but the governor of the State must send to the Secretary of the Treasury a copy of the report made to him by the colleges or stations.

SECTION 4—DECEMBER 16, 1895.

The Solicitor of the Treasury writes: "I am of the opinion that there is no authority for an agricultural experiment station to sell its bulletins outside of the State or Territory. Congress appropriates for the publication and free distribution of the bulletins, and neither expressly nor by necessary implication authorizes their sale."

SECTION 6—AUGUST 2, 1888.

The fiscal year commences on the 1st day of July, corresponding with the fiscal year of the Government.

An agricultural station entitled to the benefits of said appropriations made by Congress can anticipate the payment to be made July 1, and make contracts of purchases prior to that time, if it shall be necessary to carry on the work of the station. Of course, no portion of said appropriations paid in quarterly installments can be drawn from the Treasury unless needed for the purposes indicated in the act; and so much of what is so drawn as may not have been expended within the year must be accounted for as part of the appropriation for the following year.

SECTION 8—JANUARY 30, 1888.

The State of New York ought to designate whether to the college or to the station, or to both, it desires the appropriation to be applied. The eighth section of the act seems to authorize the State to apply such benefits to experimental stations it may have established as it desires.

Where there are no experimental stations connected with the colleges, the legislatures of such States must connect the agricultural experiment station with the colleges already established under the act of July 2, 1862; there is no authority in the act authorizing the establishment of agricultural experiment stations independent of said colleges.

The act contemplates that where stations have already been established disconnected from the colleges, the legislatures of such States may make such provisions in regard thereto as they may deem proper; but it does not authorize the establishment of stations except in connection with the colleges that were at that time or might thereafter be established under the act of July 2, 1862.

SECTION 8—FEBRUARY 14, 1888.

Where there is an agricultural college or station which may have been established by State authority, and is maintained by the State, the eighth section of the above act would authorize the State to designate the station to which it desired the appropriation to be applied, whether to one or more, or all, and the Secretary of the Treasury should make the payment under the appropriation to whichever one the State might designate.

SECTIONS 1 AND 8—FEBRUARY 15, 1888.

(1) When an agricultural college or station has been established under the act of July 2, 1862, each college is entitled to the benefits of the provisions of said act (i. e., of March 2, 1887).

(2) In a State where an agricultural college has been established under the act of July 2, 1862, and agricultural stations have also been established, either under the act of July 2, 1862, or by State authority, before March 2, 1887, the legislature of such State shall determine which one of said institutions, or how many of them, shall receive the benefits of the act of March 2, 1887.

(3) If the legislature of any State in which an agricultural college has been established under the act of July 2, 1862, desires to establish an agricultural station which shall be entitled to the benefits of said act, it must establish such station in connection with said college.

PROVISO TO SECTIONS 1 AND 8—DECEMBER 7, 1888.

It is within the power of the legislature of any State that has accepted the provisions of said act of March 2, 1887, to dispose of the amount appropriated by Congress for said station to either one or all of the agricultural colleges or stations which may have been established in said State by virtue of either of the provisions of the act of July 2, 1862, or the provisions of said eighth section of the act of March 2, 1887.

The whole responsibility rests upon the State legislature as to how the fund appropriated by Congress shall be distributed among these various institutions of the State, provided there is one or more agricultural colleges with which an agricultural station is connected, or one or more agricultural stations.

RULINGS OF THE DEPARTMENT OF AGRICULTURE ON THE WORK AND EXPENDITURES OF AGRICULTURAL EXPERIMENT STATIONS.[a]

In connection with examinations of the work and expenditures of the agricultural experiment stations established in accordance with the act of Congress of March 2, 1887, under authority given to the Secretary of Agriculture by Congress, questions have arisen which have seemed to make it advisable to formulate the views of this Department on certain matters affecting the management of the stations under that act. The statements given below have therefore been prepared to cover the points which seem to require special attention:

EXPENDITURES FOR PERMANENT SUBSTATIONS.

This Department holds that the expenditure of funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, for the maintenance of permanent substations is contrary to the spirit and intent of said act. The act provides for an experiment station in each State and Territory, which, except in cases specified in the act, is to be a department of the college established under the act of Congress of July 2, 1862. The objects of the stations, as defined in the first-mentioned act, are evidently of such a character as to necessitate the services of scientific and expert workers. Most of the lines of investigation named in the act are general, rather than local, and involve scientific equipment and work. It is obviously the intent that the stations established under this act shall carry on important investigations which shall be of general benefit to the agriculture of the several States and Territories. The sum of $15,000, which is annually appropriated by Congress under this act for each station, is only sufficient to carry out a limited number of investigations of the kind contemplated by the act.

As the work of the stations in the different States has developed, it has been found necessary to limit, rather than expand, the lines of work of the individual stations. Thorough work in a few lines has been found much more effective and productive of more useful results than small investigations in numerous lines. When we consider the nature of the investigations, the amount of money provided for the work of each station, and the fact that the act expressly provides for only a single station in connection with each college, it becomes very clear that expenditures such as are necessary to effectively maintain permanent substations ought not to be made from the funds granted by Congress to the States and Territories for experiment stations. The maintenance of permanent substations as a rule involves the erection of buildings and the making of other permanent improvements. The sums of money which can be expended for permanent improvements under the act of Congress aforesaid are so small that it is clear they were not intended to meet the needs of more than one station in each State and Territory.

When the legislature of a State or Territory has given its assent to the provisions of the act of Congress of March 2, 1887, and has designated the institution which shall receive the benefits of said act, it would seem to have exhausted its powers in the matter. The responsibility for the maintenance of an experiment station under said act devolves upon the governing board of the institution thus designated. If the legislature of the State or Territory sees fit to provide funds for the equipment and maintenance of other experiment stations and to put them under the control of the same governing board, well and good, but this does not in any way diminish the

[a] U. S. Dept. Agr., Office of Experiment Stations Circular 29.

responsibility of the board to administer the funds granted by Congress in accordance with the provisions of said act.

The wisdom of Congress in limiting the number of stations to be established in each State and Territory under the aforesaid act has been clearly shown by the experience of the few States and Territories which have attempted the maintenance of substations with the funds granted under said act. The expense of maintaining substations has as a rule materially weakened the central station, and the investigations carried on at the substations have been superficial and temporary. It is granted that in many States and Territories more than one agriculturial experiment station might do useful work, and in some States more than one station has already been successfully maintained; but in all these cases the State has given funds from its own treasury to supplement those given by Congress. It is also granted that experiment stations established under said act of Congress and having no other funds than those provided by that act will often need to carry on investigations in different localities in their respective States and Territories, but it is held that this should be done in such a way as will secure the thorough supervision of such investigations by the expert officers of the station and that arrangement for such experimental inquiries should not be of so permanent a character as to prevent the station from shifting its work from place to place as circumstances may require, nor involve the expenditure of funds in such amounts and in such ways as will weaken the work of the station as a whole.

As far as practicable, the cooperation of individuals and communities benefited by these special investigations should be sought, and if necessary the aid of the States invoked to carry on enterprises too great to be successfully conducted within the limits of the appropriation granted by Congress under the act aforesaid.

PURCHASE OR RENTAL OF LANDS FOR AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that the purchase or rental of lands by the experiment stations from the funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, is contrary to the spirit and intent of said act. The act provides for "paying the necessary expenses of conducting investigations and experiments and printing and distributing the results. * * * *Provided, however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such stations; and thereafter an amount not exceeding 5 per centum of such annual appropriation may be so expended." The only reference to land for the station in the act is in section 8, where State legislatures are authorized to apply appropriations made under said act to separate agricultural colleges or schools established by the State "which shall have connected therewith an experimental farm or station." The strict limitation of the amount provided for buildings and the absence of any provision for the purchase or rental of lands, when taken in connection with the statement in the eighth section, which treats the farm as in a sense a necessary adjunct of the educational institution to which the whole or a part of the funds appropriated in accordance with said act might in certain cases be devoted, point to the conclusion that it was expected that the institution of which the station is a department would supply the land needed for experimental purposes and that charges for the purchase or rental of lands would not be made against the funds provided by Congress for the experiment station. This conclusion is reenforced by considerations of a wise and economic policy in the management of agricultural experiment stations, especially as relating to cases in which it might be desirable for the station to have land for experimental purposes in different localities. The investigations carried on by the stations in such cases being for the direct benefit of agriculture in the localities where the work is done, it seems only reasonable that persons or communities whose interests will be advanced by the station work should contribute the use of the small tracts of land

which will be required for experimental purposes. Experience shows that in most cases the stations have had no difficulty in securing such land as they needed, without expense, and it is believed that this may be done in every case without injuriously affecting the interests of the stations.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR CARRYING ON FARM OPERATIONS.

This Department holds that expenses incurred in conducting the operations of farms, whether the farms are connected with institutions established under the act of Congress of July 2, 1862, or not, are not a proper charge against the funds appropriated by Congress for agricultural experiment stations in accordance with the act of Congress of March 2, 1887, unless such operations definitely constitute a part of agricultural investigations or experiments planned and conducted in accordance with the terms of the act aforesaid under rules and regulations prescribed by the governing board of the station. The performance of ordinary farm operations by an experiment station does not constitute experimental work. Operations of this character by an experiment station should be confined to such as are a necessary part of experimental inquiries. Carrying on a farm for profit or as a model farm, or to secure funds which may be afterwards devoted to the erection of buildings for experiment station purposes, to the further development of experimental investigation, or to any other purpose however laudable and desirable, is not contemplated by the law as a part of the functions of an agricultural experiment station established under the act of Congress of March 2, 1887. Section 5 of that act plainly limits the expenditures of funds appropriated in accordance with said act to "the necessary expenses of conducting investigations and experiments and printing and distributing the results."

FUNDS ARISING FROM THE SALE OF FARM PRODUCTS OR OTHER PROPERTY OF AN AGRICULTURAL EXPERIMENT STATION.

This Department holds that moneys received from the sales of farm products or other property in the possession of an agricultural experiment station as the result of expenditures of funds received by the station in accordance with the act of Congress of March 2, 1887, rightfully belong to the experiment station as a department of the college or other institution with which it is connected, and may be expended in accordance with the laws or regulations governing the financial transactions of the governing board of the station, provided, however, that all expenses attending such sales, including those attending the delivery of the property into the possession of the purchaser, should be deducted from the gross receipts from the sales and should not be made a charge against the funds appropriated by Congress.

LIMIT OF EXPENDITURES OF EXPERIMENT STATIONS DURING ONE FISCAL YEAR.

This Department holds that expenses incurred by an agricultural experiment station in any one fiscal year to be paid from the funds provided under the act of Congress of March 2, 1887, should not exceed the amount appropriated to the station by Congress for that year, and especially that all personal services should be paid for out of the appropriation of the year in which they were performed, and that claims for compensation for such services can not properly be paid out of the appropriations for succeeding years. The several appropriations for experiment stations under the aforesaid act are for one year only, and officers of experiment stations have no authority to contract for expenditures beyond the year for which Congress has made appropriations.

This is plainly implied in the act aforesaid, inasmuch as section 6 provides that unexpended balances shall revert to the Treasury of the United States, "in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support." The annual

financial report rendered in the form prescribed by this Department should in every case include only the receipts and expenditures of the fiscal year for which the report is made.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR A WATER SYSTEM TO BE CHARGED UNDER "BUILDINGS AND REPAIRS."

This Department holds that expenditures by agricultural experiment stations from the funds appropriated in accordance with the act of Congress of March 2, 1887, for the construction of wells, cisterns, ponds, or other reservoirs for the storage of water, and for piping, and other materials for a system of storing and distributing water, are properly charged, under abstract 18 in the schedule for financial reports prescribed by this Department, as being for improvements on land which have hitherto been held to come under the head of "buildings and repairs." The fact that a water system may be a necessary adjunct of certain experimental inquiries does not affect the case, inasmuch as the limitations on expenditures for improvements contained in section 5 of the act of Congress of March 2, 1887, expressly stipulate that these improvements shall be such as are necessary for carrying on the work of the station.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR MEMBERSHIP IN AGRICULTURAL AND OTHER ORGANIZATIONS.

This Department holds that membership fees in associations and other organizations are not a proper charge against the funds appropriated by Congress in accordance with the act of March 2, 1887, except in the case of the Association of American Agricultural Colleges and Experiment Stations, which is held to be an essential part of the system of experiment stations established under said act.

THE BORROWING OF MONEY TO PAY THE EXPENSES OF AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that experiment station officers have no authority to borrow money to be repaid out of appropriations made under the act of Congress of March 2, 1887, and that charges for interest can not properly be made against funds appropriated under that act.

A. C. TRUE, *Director.*

Approved:

J. STERLING MORTON, *Secretary.*

WASHINGTON, D. C., *March 10, 1896.*

THE USE OF EXPERIMENT STATION FUNDS FOR COLLEGE PURPOSES.

This Department holds that no portion of the funds appropriated by Congress in accordance with the act of March 2, 1887, can legally be used, either directly or indirectly, for paying the salaries or wages of professors, teachers, or other persons whose duties are confined to teaching, administration, or other work in connection with the courses of instruction given in the colleges with which the stations are connected, or in any other educational institution; nor should any other expenses connected with the work or facilities for instruction in school or college courses be paid from said fund. In case the same persons are employed in both the experiment station and the other departments of the college with which the station is connected a fair and equitable division of salaries or wages should be made, and in case of any other expenditures for the joint benefit of the experiment station and the other departments of the college the aforesaid funds should be charged with only a fair share of such expenditures.

A. C. TRUE, *Director.*

Approved:

JAMES WILSON, *Secretary of Agriculture.*

WASHINGTON, D. C., *October 25, 1897.*

ANNUAL REPORT OF THE ALASKA AGRICULTURAL EXPERIMENT STATIONS FOR 1901.

By C. C. Georgeson, *Special Agent in Charge.*

The leading features of the Alaska investigations during the year 1901 have been the further clearing and improving of land, the growing of experimental crops, the opening of the station at Rampart, on the Yukon, the distribution of seed, and a reconnoissance of the region between Eagle, on the Yukon, and Valdez, on Prince William Sound. We have, in addition, as heretofore, superintended the meteorological observations along the Alaska coast.

At Sitka but little more land has been cleared, but a good deal has been done toward the improvement of that already cleared. At the Kenai Station likewise additional land has been cleared, broken, and put in condition for culture, and at the Rampart Station as much land was cleared as one man could get in condition in time for spring planting.

The experimental croppings have been chiefly directed toward ascertaining what can best be grown in this climate, and how crops should be treated for the best results. By the distribution of small packages of seed grain to persons who seemed likely to undertake the work an effort has been made to have the common hardy cereals tested over as wide an area as possible. However, but very few reports from these volunteer experiments have been received at this writing. Garden seeds and some flower seeds have also been distributed to about 500 persons in the Territory, who either are or ought to be interested in the development of agriculture. The seed distributed is much appreciated for the reason that it is a difficult matter for settlers anywhere, except along the seacoast, to obtain seeds.

The examination of the interior from Eagle to Valdez, with a view to get information in regard to its agricultural possibilities, the writer regards as an important piece of work preliminary to the opening of one or more stations in that region. A detailed report on the subject is submitted herewith (p. 283).

The season has, on the whole, been unfavorable. Of the four years during which work has been in progress, this has been the worst. The spring and early summer were abnormally dry, which retarded the growth of crops, and the latter half of the summer and the entire fall have been abnormally wet, which prolonged the growth and made

it difficult to harvest the grain after it was grown. But in spite of these drawbacks the results may be justly said to be satisfactory, especially here at the headquarters station. We have matured rye, wheat, barley, oats, and buckwheat, and successfully grown all the leading hardy vegetables. At the Kenai and Rampart stations the experiments have also been successful in a large measure, and our knowledge of the agricultural possibilities of the Territory has been materially extended.

There are many things that it was planned to accomplish this year which have not been done for want of funds to work with. The headquarters building at Sitka has not been completed, as was planned. Only the lower story is in condition for use. The porch has not been built, no heating plant has been put in, and the foundation between the piers on which the house rests has not been built up. Nor has anything been done toward equipping a laboratory with apparatus for simple chemical and botanical work. Likewise nothing has been added in the line of implements, work animals, or other live stock, all of which must be supplied before it is possible to do creditable work along scientific lines.

On the other hand, three much-needed buildings have been put up, namely, a barn and a small cottage at the Sitka Station, and a log building at the Kenai Station, which is intended for the combined purposes of a dwelling for the superintendent and a storehouse for seed, grain, and other articles that should be well protected. None of these buildings has been entirely completed at this writing.

WORK AT SITKA STATION.

There are now 4 acres of new ground under culture at the Sitka Station, and 2 acres more have been cleared and thoroughly ditched preparatory to being underdrained. It should be noted, however, that while the ground is under culture it is not thoroughly subdued. It takes time and tillage to bring the new, raw land into a thoroughly satisfactory condition. Aside from the station land, I have had the use of three lots in the town of Sitka, which belong to the Russian Church, and which aggregate about an acre and a half in area.

EXPERIMENTAL CROPS.

The following varieties of grain were grown the past season. The leading characteristics of each are brought out in the notes on its habit and growth.

RYE.

Swedish winter.—One of the lots in town belonging to the Russian Church was seeded to wheat on October 3, 1900. The seeding was late, for the reason that the growing crops had first to be removed,

there being no other available land. It was sown in a poor, gravelly soil containing very little plant food, and it was therefore necessary to give it a dressing of fish guano at the rate of 300 pounds to the acre. Many varieties of wheat were sown, but not one of these survived the winter. The Swedish winter rye was the only kind that came through alive. Owing to the late seeding it did not make much growth in the fall; it was in rather weak condition in the spring and the early growth was slow. By June 15 it had reached the height of 22 inches, and was then beginning to head. By June 24 it was two-thirds headed. July 1 it was all headed out and beginning to bloom. July 18 it was 4 feet 9 inches high, and part of it still in bloom. August 1 the grain was all formed, and August 15 it was in the dough. September 15 it was ripe, and was harvested on September 17. As noted, the soil was poor and the yield was not heavy. The value of the experiment lies wholly in the fact that it was a winter grain and survived the winter uninjured.

Although the winters are not severe on the coast, they are, nevertheless, trying on winter grains when the snowfall happens to be light. Last winter there was not to exceed 1 foot of snow on the ground at any time, and it did not last more than two weeks at any time. The frequent thawing and freezing of the ground were the cause of winterkilling of the wheats above noted and not the cold weather.

WHEAT.

Romanow spring.—This is the only variety which was seeded this year. Of the several kinds which have been tested this has uniformly given the best results, and this point settled, it did not seem wise to continue an endless variety test. The wheat was originally imported from Russia by the United States Department of Agriculture in 1897. It is a brown bearded wheat with a red berry. The qualities which commend it for cultivation in Alaska are that it matures early, stands up well, and is a good yielder. Its milling qualities have not been tested. Three small plats were seeded to this wheat, two of them being on the lots in town, the third on new ground on the farm. The two plats in the town lots were seeded May 8 and the plat on the new ground on the farm May 11. All plats were up May 27. On June 15 it was 10 inches high on the old ground and only 5 inches high on the new ground. July 1 it was 22 inches high on the old ground and only 1 foot high on the new ground. The stand in both cases was fairly good. July 18 it was 2½ feet high on the old ground and three-quarters headed; it was 20 inches high on the new ground and the heads just beginning to show. August 1 it was 3 feet high on the old ground and just passing out of bloom; on the new ground it was 34 inches high and still in full bloom. It should be

explained here that the old ground was gravelly soil, and therefore of the quality described as a "warm" soil, while the new ground was largely vegetable mold, containing much organic matter only partly decayed. The soil held moisture better during the dry season of the summer, but on the other hand it was not so warm. This explains the fact that the wheat on this ground was later in developing.

August 15 the wheat on the old ground was in the milk; on the new ground it was now 42 inches high and not entirely out of bloom. September 17 the wheat on the old ground was cut, but the wheat on the new ground was not harvested until October 3.

Almost continuous rain during the latter part of September and all of October rendered it difficult to cure this and all other grain. Advantage was taken of every rainless day to put the grain under shelter in the upper story of the barn where the wind has a clean sweep through, and by this means it was finally dried enough to thresh; but the wet weather discolored both the straw and the grain.

BARLEY.

Manshury.—A plat of this variety was seeded on new ground May 22. It was located on a little knoll which had been graded down in order to facilitate cultivation. This process exposed the subsoil, a red compact soil, apparently of volcanic origin. This red subsoil is absolutely sterile and it was therefore manured with barnyard manure, refuse silage, and a little fish guano, all three being mixed together and plowed under. The result was an excellent crop of barley. Seeded May 22 it came up June 7; was 3 inches high June 16; 1 foot high July 1; 2 feet 2 inches high July 18 and heading out; 3 feet high August 1 and in bloom. August 15 the grain was in the milk. On August 26 part of it was ripe and harvested. That portion which was not ripe grew in heavily manured spots, and the season of growth was therefore prolonged.

Sisolsk.—This variety was introduced by the Department of Agriculture from Russia. The seed here used was grown at the Sitka Station in 1900. A plat was seeded on new ground May 22. It was up June 7. June 15 it was 3 inches high. July 1 it was 8 inches high. The stand was very uneven owing to the quality of the new ground. July 18 it was 2 feet high and just beginning to head out. August 1 it was 32 inches high, fully headed and beginning to bloom. August 15 it had passed out of bloom and the grain was in the milk. September 4 it was ripe, but owing to continual rainy weather it was not harvested until September 24. As I remarked in last year's report, I consider this a promising variety. The straw is stiff and stands up well during storms. It is a six-rowed variety with large heads.

Manchuria.—A variety of barley obtained from the Minnesota Experiment Station. It resembles the Manshury so closely that it is difficult to distinguish one from the other. It was seeded May 22 on

new ground, on a plat located alongside of the two foregoing. On June 15 it was 3 inches high, with a good stand. July 1 it was 8 inches high, and owing to the new ground it was very good in spots and very poor in other places. July 18 it was 2 feet high and heading out and some heads in bloom. August 1 the best of it was 3 feet 6 inches high. August 15 it was 4 feet high and the grain in the milk. September 4 it was ripe and harvested. Certain spots, where the growth was excessive, were still green at this date. It is a promising variety for Alaska, and about equal to the Manshury in both earliness and productiveness.

Lapland.—The seed was imported under this name from Lapland by the United States Department of Agriculture. Seeded May 15, on new ground, it was up May 27. June 15 it was 4 inches high with a good stand and a good healthy color. July 1 it was a foot high and looked well on one-half the plat; the other half was stunted, owing to the character of the new ground. July 18 it was 28 inches high and nearly all headed out, beginning to bloom. August 1 the grain was formed. August 15 the grain was in the milk and August 26 it was ripe and harvested. This is the earliest variety of barley that we have found and it is apparently well suited to Alaska. The straw is short and the heads not large, but it stands up well and as here shown matures early. It is a so-called four-rowed variety.

Black Hulless.—A plat of this variety was seeded May 22 on new ground. It was up on June 7. On June 15 it showed a rather light stand and was 5 inches high. July 1 the growth was spotted, owing to the character of the new ground, the best of it 8 inches high. July 18 it was 20 inches high and a few heads showing. August 1 the best was 2 feet 6 inches high, beginning to bloom. August 15 it was 34 inches high and the grain forming. September 4 it was ripe, but owing to the continuous rain it was not harvested until September 23. This well-known variety is not a large yielder, but its earliness recommends it for use in Alaska. Moreover, the naked kernels make it possible for the Indians to use it in their primitive ways of cooking without being milled. For this reason I recommend that it be introduced in Indian communities. Our experiments have proved that it can be grown successfully in Alaska, and if the Indians were made familiar with its qualities, it ought to become popular among them as an addition to their very limited list of foods.

Chevalier.—The plat of this two-rowed variety was seeded on old ground in one of the town lots May 7. It was slow in coming up and made a poor growth all through the season. On June 15 it was only 3 inches high. July 1 it was 6 inches high. August 1 the best of it was 20 inches high. August 15 the best was 26 inches high and just beginning to bloom. This variety did not ripen. It can not be recommended for Alaska.

OATS.

Burt Extra Early.—One of the town lots was seeded to this variety May 9. The ground had been cultivated for years. It was up on May 18. On June 15 it was 3 inches high and the stand was excellent. July 1 it was 18 inches high and very promising. July 18 it was 30 inches high and almost entirely headed. August 1 it was 34 inches high and just past blooming. August 15 it was 3 feet high, the grain in the dough, and some of it beginning to ripen. It was ripe on August 26 and harvested on August 30. This is one of the most promising varieties of oats that we have tried. It has never failed to mature, and it can be recommended for all sections of Alaska, wherever grain can be grown. It is not a vigorous grower, nor does it yield as heavily as many of the later sorts. Its earliness is its chief recommendation.

North Finnish Black.—The station was supplied with about 2 bushels of seed of this variety. It was imported from Finland by the United States Department of Agriculture. Its origin would lead one to conclude that it would prove to be a very early variety. This, however, was not the case. It was seeded on new ground May 22. On June 7 it was up; on June 15, about 3 inches high, and the stand was excellent. July 1 it was 8 inches high, and the growth was spotted, good in places, poor in others, owing to the character of the new ground. July 18 it was about one-fourth headed and the best 2 feet high. August 1 it was 3 feet high and beginning to bloom; August 15, still in bloom, and the best of it had lodged. It does not seem to stand up well. Some of it was forming seed. Many of the plants continue to send out new shoots from the roots, so that it is in all stages of growth, some sprouts a few inches high, some of it heading, while the earliest is forming grain. September 10 there were many mature heads in the plat, but it was so uneven it could not be harvested. September 24 some of the ripest was cut, but the greater portion was still green. It should be noted that the ground is not well suited to variety tests. It was new and of uneven quality, but as far as results of this experiment would indicate, this variety has nothing to recommend it for Alaska above many other sorts of medium early oats.

FERTILIZER EXPERIMENTS WITH OATS.

With a view of testing the effectiveness of certain available fertilizers on new ground, six plats were laid out, each one-twentieth of an acre in extent, 1 rod wide by 8 rods long. The plats were treated as follows: Number one was fertilized with seaweed at the rate of 30 tons to the acre plowed under. Number two was fertilized with stable manure at the rate of 30 tons per acre. Number three was fertilized with fish guano from the Killisnoo factory at the rate of 500 pounds per acre. Number four was fertilized with 30 tons of seaweed plowed

under and 500 pounds of guano sown broadcast after plowing. Number five was fertilized with stable manure at the rate of 30 tons per acre plowed under and 500 pounds of fish guano per acre scattered broadcast after plowing. Number six was not fertilized. May 22 all of these plats were seeded broadcast with Finnish Black oats (the station does not own a grain drill). On June 7 all plats were up and showed no appreciable difference in color or growth. On June 15 there was a decided difference in the appearance of the plats. They ranked as follows in order from the best to the poorest: First, manure and guano; second, seaweed and guano; third, manure; fourth, seaweed; fifth, guano, and sixth, nothing. The manure and guano plat made the best showing. The growth was 4 inches high. From this the plats ranged down to an inch and a half. July 1 the several plats still ranked in the same order. The manure and guano plat has an excellent stand; the oats are very even and 10 inches high. The seaweed and guano plat is not quite so good; the stand is somewhat uneven and the growth 9 inches high. The same ratio holds good for the others, except the plat with no fertilizer. Here the crop is but 3 inches high and beginning to turn yellow.

July 18 the same rank was still maintained for the several plats. The plat fertilized with manure and guano was the best, the crop even and 2 feet high. The plat without any fertilizer was the poorest; the crop was uneven—in places entirely dead—and the best only 5 inches high. August 1 the same rank was still maintained. The height of the crop on the several plats was as follows: Manure and guano, 40 inches; seaweed and guano, 36 inches; manure (only), 30 inches; seaweed (only), 20 inches; guano (only), 20 inches. No fertilizer had by this time a very poor stand, and the best plants were only 12 inches high.

August 15 the fertilized plats ranked as before; all were in bloom, and the oats were lodging in spots. All the manured plats exhibited the characteristics noted in the description of the variety test referred to above, namely, that of sprouting from the roots. The storms which set in about this period beat the grain down. The earliest heads lodged and did not fill well. By September 10 some of it was ripe, but it would have been difficult to gather the ripe grain from the green suckers, and it was therefore left to be cut for hay. But almost incessant rain during September and October made it impossible to cure hay, and the plats were therefore not cut until November 1. When dry enough to be weighed the yield of hay for the several plats was at the following rates per acre: Plat fertilized with stable manure and guano yielded 1.67 tons; manured with seaweed and guano, 1.63 tons; fertilized with stable manure only, 0.8 ton; fertilized with seaweed only, 0.6 ton; with guano only, 0.6 ton, and with no fertilizer, nothing—only a few pounds.

The experiment simply proves in an emphatic way a fact which I have endeavored to point out in every report, namely, that new cleared and broken land is unproductive unless it is fertilized. It seems to lack available plant food, and it does not become productive until, by cultivation and exposure to the air, the inert plant food becomes available.

Prospectors and others who clear a piece of new ground and scatter a few seed are very generally disappointed in the result, and as a rule they blame the climate for their failure. The trouble lies in the fact here noted more than with the climate.

OATS AND PEAS.

All the new ground which was cropped for the first time this season was seeded to oats and peas. Fish guano at the rate of 300 pounds per acre was sown broadcast after the ground was plowed, and the grain was also broadcasted. Oats and peas mixed were grown, partly because we have found that no other crop does as well on new, raw ground, and partly because the crop was needed for feed. The crop was uneven in stand and in growth, as it always is the first year or two on new ground, but on the whole it was quite satisfactory. The seed was not of selected varieties, but common oats and field peas, such as are offered for sale for feed. Seedings were made at several times from the first to the middle of June as the ground was gotten ready. We began cutting the crop for feed in the middle of September, and from that date until the 2d of November it was fed daily to the work oxen. The oats in the early seedings matured.

BUCKWHEAT.

Orenborg.—The station was supplied with a small quantity of seed which had been imported from Russia by the United States Department of Agriculture. A small plat was seeded May 22 on new ground. June 15 there was a good stand, but it had made but little growth, and the same applies to the condition July 1. On July 18 it was 12 inches high and blooming profusely. On August 1 the earliest blossoms had formed seed and it continued to bloom profusely. August 15 the first-formed grain began to harden. It was ripe September 5. This variety of buckwheat and also a so-called Finnish buckwheat, likewise imported by the United States Department of Agriculture, can be grown successfully in Alaska. But Japanese buckwheat and Silver Hull buckwheat, favored varieties in the States, have quite generally been failures at the Alaska stations.

FLAX.

Riga.—A small plat of new ground was seeded to flax of this variety in order to test the soil rather than the flax. The same variety was

grown at the station in 1899 on old ground with marked success. It then attained the height of 3 feet, produced a fiber of good quality, and matured seed; but on new ground it is not a success. The crop was stunted, the best not attaining 1 foot in height. This result was expected under the circumstances.

VEGETABLES.

Small plats were planted with the following kinds: Cabbage—Early Jersey Wakefield; cauliflower—Early Snow Ball, Extra Early Paris; kale—Scotch Curled; Brussels sprouts—Improved Dwarf; kohl-rabi—Large White; peas—Earliest of All; beans—Broad Windsor, Golden Wax, Early Valentine; carrots—Half Long Scarlet; parsnips—Hollow Crown; beets—Early Egyptian; onions—Yellow Danvers; turnips—White Milan; garden cress; mustard—White London; celery—White Plume; celeriac.

These were grown in small plats, both on old ground and on new. On the old ground the results were highly satisfactory. I have never seen better kale, cabbage, Brussels sprouts, or cauliflower than were grown on a little corner of old ground at the base of Castle Hill. Some of the cauliflower heads measured 14 inches in diameter. The celery and celeriac were likewise good, and so were carrots, parsnips, and the other root crops.

On new ground, on the contrary, all these vegetables were but little short of failure, and had they been grown on new ground only, one might seemingly have been justified in stating that they could not be grown in Alaska. This is simply further proof of the oft-repeated fact that it requires some years to bring the soil into condition for satisfactory growth of crops of any kind.

I do not consider it necessary to carry out extensive experiments in the cultivation of vegetables. That all the common, hardy kinds can be grown to perfection in Alaska has been demonstrated so repeatedly in nearly every part of the Territory, in the interior as well as on the coast, that there is no further need of proof. The experiment stations should hereafter grow vegetables with a view to test the different methods of culture. The new ground at the Sitka Station is not yet in sufficiently good condition for that line of work.

For detailed results in the growth of vegetables elsewhere, I respectfully refer to the letters from people who have received seed from the experiment station, which are submitted herewith (pp. 316–336). For Sitka the letter from Mrs. George Stowell gives full details of crops grown in her garden the past season, and her experience is duplicated by dozens of others.

POTATOES.

Pride of North Dakota.—A corner of new ground, cropped for the first time this year, was planted to potatoes of this variety. None

were planted on old ground. The seed was grown at the station in 1900 and kept over winter in perfect condition. The first row was manured with seaweed at the rate of 30 tons per acre. The second was manured with fish guano, at the rate of 500 pounds per acre, and the third row was not fertilized. The fourth was manured with seaweed again, and so on through the whole patch. Although the crop was but light and can scarcely be called a success, the experiment is nevertheless of interest, because it shows that seaweed, so abundant everywhere along the coast, is an excellent fertilizer for potatoes. The guano, likewise, showed its effect, but not to the same degree. The rows which were not fertilized produced practically no potatoes. The ground was a vegetable mold which would ordinarily be considered rich, and with continued cultivation it will be productive in two or three years.

SMALL FRUITS.

Cuthbert raspberries.—Some plants were obtained from an old plantation, in Governor Brady's garden, and transplanted to a corner at the base of Castle Hill. The plants grew with great vigor and in spite of having been transplanted produced berries from the beginning of August until frost. The red raspberry is indigenous to Alaska, and flourishes in the coast region to perfection, and it can also be grown along the Yukon River.

Red currants.—I have obtained a few bushes by purchase and also procured cuttings from neighbors. These are doing well. It is the intention to use them for propagation if the proposed nursery is established. None of the station bushes has borne fruit, but vigorous bearing bushes can be found in nearly every garden in Sitka and other coast towns. The same may be said of the black currant.

Gooseberries.—Gooseberries are less common than currants, but they do well everywhere in the coast region. A few bushes have been procured with a view to use them for propagation.

NEW STATION BUILDINGS.

A NEW BARN.

The past year we have built a barn at the station 25 by 50 feet in dimensions and two stories high. The lower story is built of logs and the second story is frame. An illustration is submitted herewith. (Pl. VIII, fig. 1.) The logs were cut in the winter of 1899 and 1900, but there was not snow enough on the ground that winter to enable us to haul them out of the woods. During the past winter there was snow enough to haul them for only two weeks and the marshy ground over which we had to drive was not frozen solid for a much longer period, which proves incidentally that the winters are not severe at Sitka. The barn is not entirely completed at this writing, but the

FIG. 1.—ALASKA STATIONS—BARN AT SITKA.

FIG. 2.—ALASKA STATIONS—NEW COTTAGE, SITKA.

work on it is sufficiently advanced that it is in use. The lower story is intended to be used for a stable, for the housing of implements, and a tool room for hand tools. The second story is designed to be used exclusively for the storing and handling of grain. To this end it is provided with a tight floor and, as may be seen in the illustration, there are large doors on both sides. These doors are intended to provide a free circulation of air, so the barn floor can be used as a place to dry grain in the protracted rainy season. It is a bank barn, with a driveway on the north side about 6 feet higher than the floor of the lower story. This facilitates the unloading of grain in the second story. It will be seen that it is connected with the silo, which is filled from the same driveway.

BUILDING A FARM COTTAGE.

Pl. VIII, fig. 2, illustrates a little two-story cottage which has been built on the farm in order to enable a man to live permanently on the place. The interests of the work require that there be constantly someone on the farm. The building is 30 by 14 feet, and when completed it will have two rooms and a kitchen below and two rooms above.

Both the barn and the cottage were built by Assistant Rader with such help as was hired on the farm. The financial outlay for these buildings amounts to little more than the price of the materials.

DRAINAGE.

In former reports attention was called to the necessity for thorough underdrainage of all low-lying ground, and also to the fact that portions of the cleared land had been underdrained with brush drains; that is, the ditches were filled with small brush, carefully packed in at an angle, and in such a way as to leave interstices through which the water can pass. These drains have given satisfaction so far. Their durability is the only doubtful point.

I believe we have discovered an improvement on the brush drain by the partial substitution of slabs for brush. Slabs are the first, or outside, cut of logs which are cut up for lumber in the sawmills. These slabs can be had very cheaply. They have been obtained in the past for 50 cents a load of about twenty-five pieces. When the bottom of the ditch is in firm ground, two slabs set on edge and leaned against each other in the form of an A will make a good conduit for the water. The two pieces are held securely together by a nail here and there where the two edges meet, and there will always be abundant openings for the water to get through. On top of this conduit are packed, first, poles, then coarse brush, and, finally, smaller brush, and on top of the brush, first sod and then earth. The materials cost but little for a drain of this kind; it is chiefly a matter of labor.

When the bottom of the ditch is soft, two slabs are put together in the shape of a V, in the middle of the ditch, and a third slab is nailed on top so as to leave a triangular water passage. On top of this are packed poles and brush as before. The writer believes that this kind of drain will last for many years. Slabs can usually be procurred from sawmills everywhere, and as the mills multiply settlers can procure them in many instances near by their farms.

At the Sitka Station we are experimenting in this manner, with the drainage of about 2 acres of peaty soil. The object is to see what the productiveness of such a soil is when brought under culture. There are extensive areas of peat in Alaska, and it is important to know if such land has any agricultural value. In this instance it was found necessary to place the drains 15 feet apart. The work is not completed at this writing.

NATIVE GRASS FOR SILAGE.

I stated in my last report that the log silo which was built in the summer of 1900 had been filled with native grass. It gives me pleasure to report now that this experiment was a complete success. The silage kept well in this log structure and made a feed of good quality. Our oxen were fed on it almost exclusively during the past winter. They ate it readily and kept in fair condition. They were given a little grain in addition only when they were worked. On the top and around the sides there was a certain amount of decayed silage, but no more than is found in all cases when green forage is packed away. We found that this waste silage had some value for manure on certain plats of soil. The grass was cut on a natural meadow skirting a bay some distance from Sitka, where it grows in abundance. It was then loaded into a scow and the scow was hauled to the beach at the nearest point to the farm by our steam launch. The grass was 2½ to 3 feet in length. It was thrown into the silo and tramped down at intervals during the process of filling. It settled into a very compact mass which was removed when wanted for feed by slicing it down with a hay knife.

During the latter part of August and the beginning of September of the present year the silo was again filled in the same manner, and as before it has resulted in a fine quality of feed. Not only will native grasses make good silage, but our log silo demonstrates the fact that it is not necessary for the farmer to go to great expense in building a silo. He can himself build one of logs. The logs should, however, be dressed on the inside and laid so as to make a nearly smooth wall. They should be fitted well upon one another and the openings between them should be chinked with moss, clay, or mortar in the usual manner.

FIG. 1.—ALASKA STATIONS—STATION BUILDING, KENAI.

FIG. 2.—ALASKA STATIONS—RECENTLY CLEARED LAND, KENAI.

WORK AT KENAI STATION.

On June 2 I left Sitka on the steamer *Newport*, for the westward, with a view to first visit the experiment station at Kenai on Cook Inlet, and then go to Unalaska, and from there to St. Michael and up the Yukon River in the interest of these investigations. The steamer *Newport* touched at Homer and Seldovia, at the mouth of Cook Inlet, but did not go up to Kenai. I had expected to reach Kenai from Homer on some passing boat, but there appeared to be very little traffic on the inlet. I waited a week at Homer without an opportunity to go up. The Cook Inlet Coal Fields Company, who own all the improvements at Homer, kindly accommodated me with quarters during this enforced stay, which was duly appreciated, as I was not provided with a camping outfit. At the end of a week I felt compelled to hire a sailboat in order to reach my destination. I induced the owner of a small sloop, which was put to sea on the high June tide, after having been on dry land all winter, to take me up there. We reached Kenai after a somewhat adventurous sail of two days and nights. The wind was unfavorable and the tides are so swift in the Inlet that the boat was at times carried back almost as fast as it had advanced.

I found the work at the Kenai Station advancing favorably. Mr. H. P. Nielsen, who has been in charge of the station from the beginning, deserves much credit for the amount and quality of the work which he has accomplished. Except for a few days on special occasions he has never had more than one man to help him, and most of the time he has been alone. He has built a barn and silo, both of logs. He has also built a station building intended for quarters for the superintendent and also to furnish storage room for seeds and specimens. A photograph of this building as it appeared at the time of my visit is reproduced in Pl. IX, fig. 1. The building was not finished at that time, but it has since been completed. He has cleared, fenced, and put under culture about 6 acres of land and more ground is cleared, off and on, whenever time can be spared from work required by the growing crops. (Pl. IX, fig. 2.) There has been but one yoke of oxen at the Kenai Station and one of these is getting old and gradually giving out. To replace him I bought a yearling from one of the residents and turned him over to Mr. Nielsen's care. Oxen are, in my judgment, the most satisfactory work animals for the pioneer Alaska farmer. The station oxen at Kenai live wholly on native feed, and are, therefore, maintained at practically no cost, except the labor of providing the feed. For stump pulling, plowing new ground full of roots, etc., oxen are far superior to horses. We have worked the oxen at Kenai in harness from the beginning. The yoke is used only to

keep them together. The harness is easier on them than the yoke and they can, therefore, get through with more work. I took a photograph of the oxen with their harness, and as it may be of service to other pioneer farmers, it is reproduced in Pl. X, fig. 1. The arrangement is very simple. It consists of a collar over which a pair of hames are buckled. A backband supports the traces and a strap under the chest holds them in place. Chains are used for traces. I bought this harness in Seattle, made to order at a cost of $12 for the double set.

It has been our policy to gradually extend the clearing of land when time could be spared from other work. The timber is small and the task is not a difficult one, but the stumps are numerous, and it became necessary to devise some plan by which they could be pulled rapidly. The roots do not grow deep and it does not take great power to pull the average stump. A machine which was set up over the stump and worked by hand was first tried, but it proved to be too slow work, and it was too cumbersome to move. As a cheap and efficient means to aid in this work, I devised a simple stump-pulling tackle, consisting of two triple blocks and 300 hundred feet of 1-inch rope. One block is anchored to a solid stump and the other is attached to the stump it is desired to pull. When secured in this way the oxen are hitched to the rope and driven up slowly, and the stump usually comes out without trouble. The method of using this tackle is illustrated in Pl. X, fig. 2. Two men and a yoke of oxen pulled 6 stumps in fifty minutes while I was there. I mention this fact only to show that it is a simple and efficient machine.

The illustrations show the method of attachment when the stumps are cut high, or when they are very small. When the stumps are 12 inches in diameter, or when cut low so as to afford no leverage, we use a device of two timbers about 6 feet high, fastened together in the form of the letter A. To the top of this A is attached a chain or wire rope some 4 or 5 feet long and terminating in a hook. The A leans against one side of the stump and the hook is attached to a large root on the other side. The power is then applied to the top of the A, and as this is raised up the stump is tilted over. The device simply affords greater leverage than when the block is secured directly to the stump, as shown in the illustration.

The station had about 5½ acres in crops, most of which consisted of grain. Winter wheat and winter rye had survived the cold weather and came out in the spring in fair condition, though the stand was in no case the best. A full line of the hardy vegetables had been planted, but the cabbage and cauliflower had been nearly destroyed by insects, and it was then too late in the season to raise new plants. Other vegetables were fairly promising, and the spring-seeded grains looked well.

May and June had been unusually dry. During the month of June the rainfall measured only six one-hundredths of an inch. In conse-

FIG. 1.—ALASKA STATIONS—WORK OXEN, SHOWING HARNESS, KENAI.

FIG. 2.—ALASKA STATIONS—STUMP-PULLING TACKLE, KENAI.

Fig. 1.—Alaska Stations—Hay making, Kenai.

Fig. 2.—Alaska Stations—Meadow at Homer, Kenai Peninsula.

FIG. 1.—ALASKA STATIONS—A PIECE OF CLEARING NEAR HOMER, KENAI PENINSULA.

FIG. 2.—ALASKA STATIONS—STATION BUILDING AT RAMPART, YUKON RIVER.

quence of this the crops were backward for the season. They were revived, however, by later rains. The result of the season's operations is given in detail in Mr. Nielsen's report, which is submitted herewith. Pl. XI, fig. 1, shows a view of a cart load of hay.

On the whole, the writer regards the prospects for farming on the Kenai Peninsula as very promising. The success of the work at the station has stimulated many of the natives, chiefly those of Russian descent, as well as the Indians, to raise gardens of their own, or to extend the area and increase the varieties grown in the case of those who had gardens before. Potatoes are grown very generally and very successfully everywhere in that region as their main crop, but they raise also cabbage, kale, turnips, lettuce, and radishes.

I found that I could not reach Unalaska except by waiting nearly a month at Homer for the next boat going westward, and this being impracticable, I decided to return to Sitka with the *Newport*. Through the kindness of Mr. Gompets, superintendent of the Kenai cannery, I got passage to Homer on one of the fishing steamers belonging to this cannery, and arrived there just in time for the eastward trip of the *Newport*.

I returned to Sitka, June 29, and finding that Assistant Director Allen, of the Office of Experiment Stations, would be there shortly, I decided to await his arrival before starting for the interior.

There is much good pasture land in the neighborhood of Homer. I present herewith a reproduction of a photograph of horses at pasture (Pl. XI, fig. 2). The hill country back from the beach affords also an abundance of pasture. The nature of the country is indicated somewhat by a photograph of a clearing near Homer (Pl. XII, fig. 1). The buildings in this clearing belong to the Cook Inlet Coal Fields Company.

There are enormous deposits of coal in this region. It crops out on the high bank facing the beach, several thick seams being exposed. It is said to be of good quality, and it has the peculiar property that, although it is a soft coal, it does not soil a white handkerchief. This coal deposit will doubtless play an important part in the settlement of the region.

MAIL FACILITIES FROM SITKA WESTWARD.

Before leaving this subject, I deem it my duty to mention that the mail service at Kenai, and in general between Sitka and the westward, is very inadequate. Mail is carried between Sitka and Kenai only once a month and the boat stops at Kenai only long enough to land the mail, so that it is impossible to get replies until the next mail boat. On the return trip east, the mail boat does not stop at either Kenai or Sitka. Letters addressed to the Kenai Station can not be answered for a month after their arrival, and then they are carried to

Juneau and left to be forwarded to Sitka by the next mail boat. It takes, therefore, two months to get a reply from the Kenai Station.

It would be greatly to the convenience of our work if the mail boat could stop at Kenai on her return from Tyonek, and stop at Sitka on her way to Seattle.

REPORT OF H. P. NIELSEN, SUPERINTENDENT OF KENAI STATION.

KENAI EXPERIMENT STATION,
October 5, 1901.

DEAR SIR: I hereby submit my report for this season's work.

The grain has not matured as well as it might have done, because its growth was retarded by dry weather last spring. The winter grains matured, however, as did also the barley and two or three varieties of oats. The spring wheats did not amount to anything this year.

You probably remember when you were here that none of the grains appeared to be sown too thickly. Well, this fall when the wet weather set in, for every straw there was previously, ten sprang up from suckering, and now in each one of these bunches, especially in the oats, there is the original straw in the center with ripe grains, and all of these shoots are from 6 inches to 1 foot taller than the original stalk, but green. And it has kept this up right along. All through the oats and Manshury barley there were young shoots not headed out yet, others just heading, some in bloom, and all the way up to ripe grain, but the latter is but a small percentage of the whole. All the grains suckered in this way until it was thicker than hair on a dog's back.

The flax also, as you will notice, from sample sent, acted peculiarly. The seed which germinated early produced plants, which branched considerably but were of no value for fiber, while that which came up in July reached a height of 2 feet or a little over, and has very fine straight straw.

The ground is fertile; what it wants is cultivation and water. When the rain came everything started to grow, and grew fast, so fast that in fact it would not stop growing until the frost stopped it.

I did not keep any record of the growth of the field peas, but all the patches on which the stand of grain was not good were sown to field peas June 21. On account of the ground being so dry they did not come up until about July 10, and some as late as the 15th. They then made a good vigorous growth, however, and were about 2 feet high and in bloom when they were cut for hay September 16 and 17.

BUILDING OF STATION HOUSE.

I started to cut logs for the house the latter part of last October. Logs have been cut for building houses here in Kenai for a hundred years, and all the handy timber has been cut away. By going back about 2 miles, though, I found house logs, but they were scattering.

After cutting the 140 logs which I needed, I had logs here and there over half a square mile. To collect them I made a small sled just wide enough for the big end of the log to lie on, and used one of the oxen to drag them together. After I had them all piled up, I cut a road wide enough for the big sleigh and hauled them home with both oxen; this took until New Year. I finished hewing them February 21, and in the first part of March hired C. H. March to help me lay them up. The house was so nearly completed by the last of June that we moved into it, and the remainder of the inside work has been done since on rainy days.

CLEARING LAND.

About 1½ acres additional land has been cleared this summer, stumps pulled, land plowed and disked, and it is now ready for cropping next year. This land is cleared about a quarter of a mile back in the woods, leaving a belt of timber between it and the sea. The southwest wind blowing up the inlet is always cold, and is thought to be a drawback to vegetation.

Sufficient hay for keeping the oxen and a yearling calf, bought this summer, has been cut and gathered during the summer. No grass has been put in the silo, chiefly because it is difficult to get grass near here, as the cattle have it pretty well pastured down. The wild grass which we use for hay grows some miles distant, and it is easier to transport the hay than the green grass.

EXPERIMENTAL GRAIN CROPS.

WINTER RYE.

Sisolsk.—A small plat of this rye was sown August 20, 1900, on new ground, which was fertilized with fish guano at the rate of 200 pounds to the acre; it came up in about ten days, and stood about 4 inches high when the ground froze. Stand uniform, but rather thin. On June 20 the stand was straggling and spotted; height 1 foot. July 1, growth straggling, some stalks 2 feet high, average 15 inches; beginning to head. July 15, 30 inches high, fully headed, and beginning to bloom. August 1, 5 feet high and in bloom; looks promising. August 15, average height 5½ feet, some stalks over 6 feet high, going out of bloom, but does not seem to be forming any seed; suckering badly. September 2, average height 6 feet, some heads going out of milk, some in the milk, and some blooming. September 16, heads white, only about 50 per cent have grain in them, straw mostly green; it was harvested September 26. At this time there were suckers in all stages, some just heading out, but the ripe straw was being broken down by strong winds. This is a new variety; the seed was imported from Russia by the United States Department of Agriculture.

WINTER WHEAT.

Sandomer.—A plat of this wheat was sown August 23, on same kind of ground as the rye. It came up in about 12 days and stood 4 inches high, when the ground froze. Stand good and uniform. On June 20 it was noted that the stand was good and uniform, 6 inches high. July 1, stand and color fairly good, 8 inches high. July 15, 15 inches high. August 1, 30 inches high, fully headed, and in bloom. August 15, 3½ feet high, still in bloom. September 2, some heads well advanced in the milk, new shoots numerous, and in bloom. September 16, lower half of straw turning yellow, heads also turning yellow. It was cut September 30. It was mostly ripe, but is not so early as the Yarasloff, and has more tendency to sucker. Seed was imported from Russia by the United States Department of Agriculture.

Yarasloff.—Sowed August 23, on the same kind of ground as the foregoing variety. It came up in about 12 days, and stood 4 inches high, when the ground froze. Stand good and uniform. On June 20, stand good and 6 inches high. July 1, stand and color good, 8 inches high; needs rain. July 15, 16 inches high, just beginning to head; promising. August 1, 36 inches high, fully headed, and in bloom. August 15, 4 feet high, going out of bloom, forming seed. September 2, in the dough, straw turning yellow, September 16, nearly ripe. It was cut September 30. The straw at this time was dry, but owing to continuous wet weather, the kernels were not quite hard. It wintered well, and on old ground and in ordinary seasons can be counted on to ripen. Seed imported from Russia by the United States Department of Agriculture.

SPRING WHEAT.

The following varieties of spring wheat were seeded May 10 and 11. Owing to the drought in spring and early summer they were slow in starting and in consequence the period of growth was shortened. None of them got fairly started to grow until the rain came, about the middle of July, and by the 1st of August they had scarcely begun to head. But from this date the excessive rain kept these wheats growing, and caused them to throw out shoots from the roots at such a rate that they formed but little grain. September 6 all were cut for hay. The varieties were Romanow, Russian, Pererodka, and Kubanka. All were imported from Russia, and all have been grown successfully at the Sitka Station. The Romanow matured at the Kenai Station in 1899.

BARLEY.

Manshury.—Seeded broadcast and harrowed in May 24 on both old and new ground, which had been given a dressing of 500 pounds of fish guano to the acre. On June 20 the stand was good, 3 inches high.

July 1, color good, but has made no growth on account of dry weather. July 15, 6 inches high, growing rapidly. Up to this time there is no difference between the growth on old and on new ground. August 1, stand uniformly 18 inches high, and 10 per cent headed on the old ground. On adjoining new ground, growth spotted, 6–30 inches high, rank spots headed. August 15, on old ground uniformly 2 feet high, fully headed; on adjoining new ground, stand 10 inches to 3 feet high, much of stunted growth not headed yet. September 2, on old ground 33 inches high; some in the bloom and some in the milk. On adjoining new ground, spotted, 15 inches to 3 feet high; rank spots in the dough, straw turning yellow. September 16, about one straw in ten with grain in the dough, the other nine-tenths are suckers, in all stages, some just heading out. On adjoining new ground, rank spots nearly ripe, stunted growth, some in the dough and some in the milk, straw green yet. It was cut October 4. Only the older heads were ripe; the suckers started too late to ripen.

Beartown.—Seeded in rows May 21 on old ground manured with fish guano at the rate of 500 pounds to the acre. On June 20, stand was good, 5 inches high. July 1, has made no growth for lack of rain. July 15, 10 inches high, running to stalk. August 1, growth spotted, 14–30 inches high, half of it headed. August 15, growth fairly uniform, 36 inches high, going out of bloom. September 2, in the dough, straw turning yellow. September 16, turning yellow and ripening. Cut October 5. This is the earliest variety of barley grown here. The only objection is that it sets too large heads for the strength of the straw. It lodges badly. It has large, plump grains. Grown from seed raised here in 1899.

Sisolsk.—Seeded in rows May 21, on same kind of ground as the Beartown. June 20, fair stand, 2 inches high. July 1, has made no growth, owing to the dry weather; turning yellow in spots. July 15, 4 inches high, yellow spots turning green again. August 1, 12 inches high, just beginning to head. August 15, 20 inches high, fully headed, about 20 per cent in bloom. September 2, 30 inches high, part of it in bloom and part in the milk, suckers numerous. September 16, about 20 per cent in the dough, the rest in all stages, straw green yet. It was cut October 5; suckers still green, early heads with firm grains in them.

Perm.—Seeded in rows May 21 on the same kind of ground as the two other varieties. June 20, stand good, 4 inches high. July 1, has made no growth on account of dry weather. July 15, 6 inches high, looks well, growing fast. August 1, 18 inches high, just beginning to head. August 15, 2 feet high and in bloom. September 2, average height, 33 inches, well advanced in the milk. September 16, in the dough and ripening. It was cut October 5. Grown from seed raised here in 1899.

OATS.

Burt Extra Early.—Sown broadcast at the rate of 2 bushels to the acre, May 24, on ground broken in 1899 and in oats last year. It was fertilized with fish guano at the rate of 500 pounds to the acre. June 20, stand fair, color good, 2–3 inches high, promising. July 1, 3–4 inches high, growing very slowly. July 15, average height 8 inches. August 1, 2 feet high, fully headed, looks promising, beginning to stool. August 15, 2½ feet high, beginning to bloom, suckers in all stages up to the heading out. September 2, well advanced in the milk, some in the dough. September 16, straw turning yellow, bids fair to mature. It was cut October 2; it was not all ripe, but a large percentage of it was; new suckers were growing up all the time.

White Russian.—Sown broadcast and covered with the harrow May 24 on new ground, which had been given a dressing of 500 pounds of fish guano to the acre. June 20, stand and color good, 3 inches high. July 1, 4 inches high, needs rain. July 15, 7 inches high. August 1, 15 inches high, beginning to head. August 15, 2½ feet high, fully headed. September 2, in the milk, standing up well. September 16, mostly in the dough, straw turning yellow and ripening. It was cut October 1; a good percentage of it was ripe. Probably the reason it stood up so well was, it was sown between the house and the woods; the house sheltered it from the south winds and the woods from the north. It was grown from seed raised here in 1899.

Siberian.—Sown broadcast May 23 on ground broken in the spring of 1900 and grown to oats last year. It was manured with fish guano at the rate of 500 pounds to the acre. June 20 the stand was fair, 2 inches in height. July 1, has made no growth. July 15, stand improved some, 6 inches high, color good. August 1, uniformly 12 inches high, a few heads showing. August 15, 20 inches high, not all headed yet. September 2, 3 feet high, about 50 per cent of it in the milk. September 16, about 40 per cent in bloom yet, 50 per cent in milk, and 10 per cent in dough, straw green. It was sown too thin, and when the wet weather set in it suckered, which accounts for the different stages. In some cases 12 straws had sprung up around the original one. It was cut October 1; only the earliest heads were ripe.

Improved Ligowa.—Seeded in rows May 16 on new ground manured last fall with fish guano at the rate of 300 pounds to the acre. June 20, stand and color good, 3 inches high. July 1, the most of it has made no growth; in spots it is 7 inches high, needs rain. July 15, growth spotted, average 8 inches high, spots 12 inches high. August 1, average height 18 inches, one-half headed. August 15, fully headed and in bloom, promising. September 2, 4 feet high, well advanced in the milk. September 16, in dough, straw turning yellow, chaff and hulls turning white. Cut October 3. This variety produces fewer

suckers than any other variety grown here; about 90 per cent of it ripened.

Black Finnish.—Seeded in rows May 22 on old ground manured with fish guano at the rate of 500 pounds to the acre. June 20, stand and color good, growth uniform, 3 inches high. July 1, color good, 4 inches high, growing a little. July 15, 7 inches high, uniform. August 1, 14 inches high, headed. August 15, 30 inches high, in bloom, promising. September 2, 3 feet high, in the milk. September 16, in dough, straw green. Chaff turning white and hulls black. Stands up well and bids fair to mature. It was cut October 5. The straw was not all yellow, but most of the grain is hard.

Tobolsk.—A plat was seeded in rows May 22 on old ground manured with fish guano at the rate of 500 pounds to the acre. Another plat was seeded broadcast May 24 on same kind of ground. On June 20 it was noted—rows, stand and color good, 3 inches high, promising; broadcasted, stand poor, 2–3 inches high. July 1, rows, stand and color good, 5 inches high; broadcasted, stand poor, had made no growth. July 15, rows, stand and growth uniform, 7 inches high; broadcasted, stand improved wonderfully. New stalks have come up since the rain, average 6 inches high, doing nicely. August 1, rows, stand uniform, 20 inches high, beginning to head; broadcasted, 1 foot high, no heads as yet. August 15, rows, 30 inches high, going out of bloom; broadcasted, 20 inches high, fully headed. September 2, rows, 3½ feet high, grain in the milk; broadcasted, suckering badly, few heads in the milk, some in bloom and some just heading. September 16, rows, grain in the dough, chaff turning white, straw green. This plat does not sucker much, and is uniform, will mature; stands up well; broadcasted, earliest heads in the milk, straw green, but the frost has turned the chaff white on all the heads. Will not mature any seed. This plat was cut for hay October 1; the straw was green and young shoots growing up all the time. The plat in rows was cut October 5. The straw was partly green, but about 75 per cent of the grain was ripe.

St. Petersburg.—Seeded in rows May 22 on old ground manured with fish guano, at the rate of 500 pounds to the acre. June 20, stand good, 2–3 inches high. July 1, has made no growth, but the color good. July 15, 5–7 inches high. August 1, stand uniform, 12 inches high, beginning to head. August 15, 2 feet high, fully headed and in bloom. September 2, 3 feet high, in the milk. September 16, 50 per cent in the dough, 50 per cent in milk; straw green, chaff on advanced heads turning white. It was cut October 5; only a small percentage of the grain was fully ripe; straw mostly green.

Zhelanni.—Seeded in rows May 21, on the same kind of ground as preceding variety. June 20, good uniform stand, 3–4 inches high. July 1, has made very little if any growth, color good. July 15, 7 inches high, growing fast. August 1, 12–20 inches high, about half

headed. August 15, the average height, 30 inches, going out of bloom. September 2, 3 feet high, in the milk. September 16, well advanced in the milk, a small percentage in the dough, with the straw turning yellow. It was cut October 5, straw mostly green, only a small percentage of firm grains. The seed was imported from Russia by the United States Department of Agriculture.

Banner.—Seeded broadcast, at the rate of 2 bushels to the acre, May 24, on both old and new ground, which had been given a new dressing of fish guano at the rate of 500 pounds to the acre. June 20, stand good, color excellent, 2 inches high. July 1, stand appears to have thickened some, but has made no growth upward. July 15, 6–8 inches high; up to this date there was no difference between growth on old and on new ground. August 1, on old ground, stand uniformly 14 inches high. On adjoining new ground, growth spotted, 6–24 inches high, no heads yet. August 15, on old ground, uniformly 20 inches high. On adjoining new ground, spotted, 8–30 inches high, stunted growth not headed, rank growth headed. September 2, on old ground, uniformly 4 feet high, mostly in bloom, some just past the bloom. On adjoining new ground, growth 18 inches to 4½ feet high, rank growth in the milk, stunted growth going out of bloom. September 16, on old ground, straw green, a small percentage in the dough, mostly in the milk. On adjoining new ground, rank growth, straw turning yellow, seed well advanced in the dough, stunted growth in the milk, straw green. It was cut October 3 and 4. Only a small percentage of grain was ripe, but the frost had turned the heads white. The straw was mostly green. On the old ground it suckered badly.

BUCKWHEAT.

Silver Hull.—Seeded in rows May 22 on ground broken in the spring of 1900 and seeded to oats last year. It had been fertilized with fish guano at the rate of 500 pounds to the acre. On June 20 it was noted just to be up, but sickly. July 1, about 20 per cent killed by drought, half the remainder drooping, and all looks sickly. July 15, 2 inches high, stand improved considerably since the rain, color fairly good. August 1, 8 inches high, in bloom, and looks fine. August 15, 1 foot high, still in bloom, no seed formed. September 2, in all stages, some in bloom, some seed just formed, and some in the milk. Killed by frost September 3, and cut September 13. I found when I cut it there was a small percentage of well-matured seed.

Japanese.—Seeded in rows, May 22, on same kind of ground as the preceding variety. It made slow growth all summer. August 1, 6 inches high, a few stalks in bloom. August 15, 8 inches high, blighted by cold wind, not looking well. Frost of September 3 killed it. It was a total failure.

Orenborg.—Seeded May 22 on same kind of ground as the other

two varieties. On June 20 only 40 per cent stand; looks sickly. July 15, stand improved since the rain. New plants coming up all the time. The few old ones not killed are beginning to bloom. August 1, spotted; 4 to 12 inches high, in full bloom. August 15, in bloom yet, some seed formed. September 2, in all stages, some blooming, seed just forming, and some seed ripe. It was killed by frost September 3, and harvested September 13. There was more seed on this variety than on the Silver Hull, but it was a partial failure.

EMMER.

Ufa spring emmer and *Yarasloff spring emmer* were tried. Seed of both varieties imported from Russia. Both matured at Sitka in 1899. The drought retarded their early growth and neither variety matured seed. Both were cut for hay September 26.

FLAX.

Riga.—Seeded May 23 at the rate of 2½ bushels to the acre, on old ground which had received a dressing of fish guano at the rate of 500 pounds to the acre. On June 20 it was just coming up. July 1, stand fair, 1 inch high. July 15, much of it is 4 inches high much more is just coming up after the rain. August 1, first half 12 inches high, beginning to bloom; second half 3 inches high. August 15, first half 2 feet high, in bloom, branching considerably; second half 8 inches high. September 2, first half 30 inches high, with some blossoms and some seed pods; second half 15 inches high, just coming into bloom. September 16, first half seed pods turning black; second half 2 feet high, in bloom. Cut October 5; very little seed is ripe. The part that came up last set no pods, though it has fine, straight straw and exceedingly tough fiber.

CLOVER.

Red.—Seeded May 30, 1900. Growth last year but light; survived the winter well, June 20, the stand was excellent, but growth not remarkable so far, the average height being about 4 inches; promises well. July 1, has made scarcely any growth; a few stalks in bloom; suffering from the drought. July 15, average height 7 inches, half of it in bloom. August 1, spotted, 6–12 inches high, 75 per cent in bloom. August 15, mowed for hay; a fair crop of hay was cut. September 2, 6 inches high. October 5, still green, but no longer growing.

Red and *Alsike* (mixed).—Seeded May 23 on ground broken in 1899 and grown to oats last year. June 20 it was just coming up. July 1, stand uncertain. More of it coming up all the time. July 15, one-half inch high; stand good. August 1, 1 inch high. August 15, 1½

inches high; growing nicely. September 2, 4 inches high. September 16, 6 inches high. At this writing it is still green and seems to be growing. I regard it as being very promising.

FLAT PEA (*Lathyrus sylvestris*).

Seeded May 30, 1900, on new ground. On June 20 there were only a few plants showing above ground. Stand good last fall. July 1, stand fair, 2 inches high; growing very slowly. July 15, 6 inches high. September 2, growth becoming spotted, 6–10 inches high. September 16, 6–12 inches high; not growing much. At this writing the plants are still green, but not growing any. The stand is good.

POTATOES.

Potatoes were grown in both raised beds and on the level ground. There was no difference in the growth or in the yields. They came up about the same time, green tops the same size, and potatoes as nearly alike in numbers and size as two peas in a pod. They were planted in ground which was seeded to oats last year. It was given a dressing of fish guano this spring at the rate of 500 pounds to the acre. The yield was about eightfold; between 60 and 70 per cent were marketable.

The potatoes were planted May 18. July 1, just coming above ground. July 15, stand good, 3–4 inches high. August 1, 8–10 inches high; beginning to bloom. August 15, tops 1 foot high, in full bloom, well set with tubers. September 2, tops 14 inches high; some still in bloom. Nipped by frost September 3, but rallied and kept growing till the 23d, when they were killed by frost. They were dug on September 26 and 27.

It is the custom of the Russians in Alaska to raise beds a foot or more high on which to plant potatoes. In the experiment here referred to part of the ground was prepared with raised beds in accordance with Russian practice, and part of it was planted in the ordinary manner in order to see if the raised beds had any merit. In this instance the result shows they had not.

VEGETABLES.

The following vegetables were planted in a cold frame April 22: Cabbage—Jersey Wakefield and Early Winnigstadt; cauliflower—Snowball, Extra Early Paris, Dwarf Erfurt; Brussels sprouts—Improved Dwarf; kohl-rabi—Large White; parsley—Extra Curled; lettuce—Thorburn Maximum Head, Early Curled Simpson, and Victoria Cabbage; broccoli— Early White.

The cabbage, Brussels sprouts, kohl-rabi, and lettuce were transplanted in the open ground June 3. A species of caterpillar was very numerous here in the spring and it ate up everything except about

twenty plants of the Jersey Wakefield cabbage. These have done fairly well, a few heads being large enough to use by September 10.

The parsley seed failed to grow.

The cauliflower and broccoli were transplanted in the open ground June 17. The cauliflower did not get very large, but began to head about the middle of August. First used for the table August 24.

The broccoli did not head. It grew leaves 2 feet high, but set no heads.

On June 1 planted the following vegetables: Peas—First and Best and American Wonder; beans—Broad Windsor, Golden Wax, Valentine Wax; spinach—Long Standing, Thick Leaved; beets—Mammoth Long Red Mangel-Wurzel and Lents Extra Early Turnip; carrots—Half-long Chantenay and Half-long Danvers; parsnips—Thorburn Hollow Crown; onions—Large Red Wethersfield and Yellow Danvers rhubarb—Linnæus; asparagus—Conover Colossal; and mustard—White London.

The caterpillars destroyed, as they came out of the ground, the carrots, parsnips, mustard, and most of the beets.

The American Wonder peas were 4 inches high and coming in bloom July 15. They had edible peas by August 10. The vines reached a height of 10–12 inches.

First and Best began blooming about the same time as the American Wonder, and had edible peas August 20. They grew nearly 4 feet tall.

The Broad Windsor beans made a vigorous growth and had numerous pods by September 1. None of them became full grown. Killed by frost September 3. The wax beans came up late in July, but were a total failure.

The spinach came up and went to seed.

The beets which were not destroyed by the caterpillars did fairly well. Some of them were 3 inches in diameter. The Mangel Wurzels, 2 inches in diameter and about 8 inches long. The onions did not do well. They were only large enough for sets. The rhubarb did remarkably well for the first season's growth and not being started in the cold frame.

The asparagus seed was a long time coming up, but the plants are about 6 inches high and thrifty.

Early Purpletop Milan turnips were sowed June 17, but the ground was so dry that they did not come up till about July 10. They made a vigorous growth and were large when pulled, October 1.

Respectfully submitted.

H. P. Nielsen,
Superintendent, Kenai Experiment Station.

Prof. C. C. Georgeson,
Special Agent in Charge of Alaska Investigations.

GROWTH OF FARMING AND GARDENING IN THE INTERIOR.

With a view to ascertaining what progress was being made in the interior along these lines of work, and more particularly to visit the Rampart Station and to see the condition of the work at Holy Cross Mission at Koserefsky, where the Father Superior had engaged to carry out certain experiments in grain growing, I started for the interior on July 19 by the overland route.

ITINERARY.

I obtained transportation from Sitka to Juneau on the revenue-cutter *Rush*, and arrived at the latter place July 20. From Juneau I went to Skagway on the *Al-Ki*, she being the first boat bound that way. I left Juneau on the night of July 22 and arrived at Skagway late in the afternoon of the 23d. On the 24th I took the train for White Horse. Left White Horse on the 25th and arrived at Dawson on the 27th. I was fortunate enough to get passage on a steamer bound for the lower river, and I reached Eagle July 28, Holy Cross Mission August 2, and Rampart August 13. I stopped here several hours, long enough to enable me to transact the necessary business in connection with the station. Mr. Jones, who had been in charge of this station for the past year, agreed to make the trip overland from Eagle to Valdez, and I therefore took him with me to Eagle, where we arrived August 18. I remained at Eagle until the 25th, when the *Leah* left for Dawson, which point was reached on the evening of the 28th. Dawson is the northern terminus for the boats on the lower river, and the distance from Dawson to White Horse is covered by boats of a smaller type, nearly all of which belong to the British Yukon Navigation Company. I left Dawson on the steamer *Yukoner* September 2, and arrived at White Horse September 7. There I took the train for Skagway, which was reached in the afternoon of the same day. I left Skagway again on the steamer *Cottage City* on September 9; arrived at Juneau on the 10th, and was fortunate enough to make immediate connection for Sitka by the *City of Topeka*.

I take great pleasure in acknowledging courtesies from the transportation companies in the interior. The White Pass and Yukon Railway Company gave me free transportation over their line; the British Yukon Navigation Company charged me for berths and meals only, and through W. H. Isom, esq., vice-president of the North American Transportation and Trading Company, I was tendered free transportation on all the boats with which he was connected on the Lower Yukon. This included the boats of the Northern Transportation Company, the interest of all lines having been pooled for the season.

GOOD GARDENS EVERYWHERE.

It was gratifying to behold the many and excellent gardens which were found along the river. At Eagle nearly every householder had a garden. Not only were the common vegetables quite generally grown, but flowers were also in evidence to a considerable extent. Many of the hardy annuals, such as poppies, nasturtiums, larkspur, and mignonette were in full bloom, and some of the more tender plants, as sweet peas, were in bloom at Eagle when I arrived there in the latter part of July, and there was abundant evidence that flowers as well as vegetables could be grown everywhere if they were given the requisite care. Such vegetables as potatoes, turnips, radishes, and lettuce could be seen nearly everywhere, and in several places cabbage, cauliflower, and kale were also grown successfully.

A resident of Eagle, who gave some attention to farming in 1900, promised to grow some grain the past season, but his interests elsewhere prevented him from doing so. It is, however, worthy of note that volunteer oats had come up in the little field he had in oats last year, and that it gave promise of a good crop. It would be difficult to adduce stronger evidence concerning the agricultural possibilities of that region than is furnished by this fact. Wherever grain will grow up, mature, and the waste seed live through the winter and produce a crop the following year, there certainly can not be much doubt but that farming is possible.

But it should also be noted that frosts are liable to occur at almost any time during the summer, and that in exposed places, especially on low ground along the river, these frosts may be severe enough to kill tender things. Thus a frost occurred in the neighborhood of Rampart and Fort Gibbon on July 31 of the present year, which injured many gardens in exposed positions, particularly those at Fort Gibbon, and the garden at the experiment station at Rampart was not entirely exempt. This frost, however, seems to have been confined to a limited area, for I did not note injury from it at Eagle nor on the lower Yukon in the neighborhood of Holy Cross Mission.

GARDENS AND EXPERIMENTS AT HOLY CROSS MISSION.

This mission is renowned in all the interior of Alaska, not only for its good work among the natives and the helping hand it lends to needy wayfarers, but also for its gardens. There are about 4 acres under cultivation, and the principal crop is potatoes, this vegetable forming one of the staple articles of food. Other kinds of hardy vegetables and a great variety of flowers are grown with marked success. While I was a guest at the mission, from August 2 to August 9, the table was daily supplied with new potatoes, lettuce, and radishes,

and frequently also with cabbage, cauliflower, beets, and turnips. What it is possible to do there would also be possible anywhere else on the lower Yukon. In the garden of the Sisters of St. Ann were also a great variety of flowers of the class known as hardy annuals. I found upwards of thirty varieties in bloom in the early part of August. The success of these gardens is, of course, largely due to the great care that is bestowed upon them. Thus there has been introduced a system of irrigation which is found of great service during periods of dry weather. A stream coming down from the hills has been dammed, a flume built, and sluices put in, so that it is possible to irrigate a considerable area of the cultivated ground. Hardly a weed could be found in the garden, and the tillage was well nigh perfect. One of the potato fields of the mission is reproduced in Pl. XIII, fig. 1, and shows a general view of the mission buildings. I have referred to the work at this mission in former reports. It may well be taken as a model in gardening.

In the summer of 1900 I entered into an agreement with Rev. Father R. J. Crimont, whereby he agreed to grow some wheat, barley, oats, buckwheat, and clovers during the past summer in an experimental way, and it was chiefly to note the outlook of these crops that I visited the mission. Owing to a rather injudicious selection of ground, the experiments were not a success. The ground was very wet naturally, and, therefore, cold, and could not be worked until late in the spring. Moreover, when the snow melted on the mountains in the latter part of May, it flooded this ground and made it all the worse. It was, therefore, not in good condition when the grain was seeded, on June 4. The growth was rapid in some places and slow in others, owing to the condition of the soil, and because of the wet ground the growth was prolonged more than it would have been on drier soil. When I was there in early August, the barley and oats had lodged in several places, grain was formed, but there was but little prospect of its maturing. A report on the experiment by Mr. V. O'Hare is submitted herewith:

Holy Cross Mission,
Koserefsky P. O., Alaska, September 4, 1901.

Dear Sir: I have the honor to report to you on the result of the grain-growing experiments instituted by you at this mission with R. J. Crimont.

Although the grains did not mature this summer, the result of the trial has shown that grain growing need not be entirely despaired of in this part of Alaska.

All chances seemed to combine against it this particular summer. The season was unusually short from June 4, when the seed was put in, until August 31, when a frost destroyed the potato tops. The seed was sown too thick, and during the second half of the season, just when the grain needed heat, the weather was uncompromisingly wet and cold.

In our more favorable seasons, provided the seeds were sown in good ground, the grain would probably mature. These favorable seasons occur every two or three

Fig. 1.—Alaska Stations—Holy Cross Mission, Yukon River.

Fig. 2.—Alaska Stations—Native Grass at Koserefsky, Yukon River.

FIG. 1.—ALASKA STATIONS—BARLEY AT HOLY CROSS MISSION.

FIG. 2.—ALASKA STATIONS—WHEAT AT HOLY CROSS MISSION.

years, hence we may conclude that grain can be successfully cultivated every few years in this part of Alaska.

I am sending samples of the wheat, barley, and oats. The frost of August 31 entirely destroyed the buckwheat. As for the clover, it grew to a respectable height, but did not blossom.

Yours, very respectfully, V. O'HARE.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

Pl. XIV, figs. 1 and 2, gives views of portions of these grain experiments. Fig. 1 shows the barley and fig. 2 the wheat.

In the neighborhood of the mission is an extensive meadow of native grass. This grass grows as high as a man's shoulder. I wanted to get a photograph of the cattle in the grass, and for this purpose asked to have them turned into the meadow, but they were entirely lost to sight when they got into the grass. Four of the five head of cattle were native born, and, of course, had lived exclusively upon native feed. They were in most excellent condition. A view of this meadow can not fail to convince the most skeptical of the fact that it is possible to grow cattle feed there in unlimited quantities. The meadow is shown in Pl. XIII, fig. 2.

WORK AT RAMPART STATION.

As stated in last year's report, a tract of land containing about 313 acres has been reserved for an agricultural experiment station opposite the town of Rampart, on the Yukon River. The tract was, and nearly all of it still is, virgin forest. The whole area is covered with spruce, interspersed with an occasional poplar and birch, and under the trees the ground is covered thickly with moss. The features which recommended this tract for an experiment station were, first, the location, and secondly, the nature of the soil, and its exposure. The greater portion of it is a gentle slope facing the south.

When I left the Yukon in August, 1900, Mr. Isaac Jones, the assistant assigned to the work in the interior, began work here, at Rampart. The means at our disposal did not admit our purchasing implements and work animals, nor could we even hire men to work. With the exception of a single laborer, who was hired for about two weeks, Mr. Jones performed the work single handed and alone with ax, mattock, and spade. He began clearing a patch of ground, grubbing out the stumps, and digging up the earth so as to get as much as possible ready for seeding, in order that we might test grain and the commoner vegetables during the present year. Mr. Jones cleared and prepared in this way about half an acre of ground. This is but a small beginning, but the best that we were able to do. The cheapest rate at which labor could be hired was $5 a day, and the lowest charge for the hire of teams was $10 a day. Could we have had a team and

two or three men, and been provided with a stump puller, and other farm implements, much more could, of course, have been accomplished. I would respectfully submit that if the work is worth doing at all it is worth the expenditure necessary to equip and maintain the station in a modest way—with a team, stump puller, plows, and other necessary farm implements. To do this, however, will cost about five times more than it would cost to equip a similar station anywhere in the States. I had Mr. Jones look up a team of horses with a view to buying them if they could be purchased within our available means. He found a team of average weight and in fair condition, which the owner was anxious to sell, but he could not afford to sell them for less than $800, and considering the expense of importing them, they were worth that; but we were unable to buy. For the same reason no house or cabin was built at this station the past year. Mr. Jones could not handle the logs alone and I was unable to authorize him to hire labor to help. He was fortunate enough, however, to get the use of a wood chopper's cabin, which had been built on the bank of the river a year or two before. It was poorly built and in a dilapidated condition, with the roof leaking so badly that until repaired Mr. Jones found it necessary to put a tent up inside in order to keep dry at night. It had a single small window, and a floor made of poles after the fashion of a corduroy road. Such were the quarters we were obliged to occupy the past year. A photograph is produced herewith (Pl. XII, fig. 2).

EXPERIMENTS WITH GRAIN.

Mr. Jones found a clump of volunteer rye in the lot back of the North American Transportation and Trading Company's store. How it got there nobody knew, but in all probability it was a handful which had been scattered from a sack of feed. It was a fall variety which had stood the winter and had come out in the spring in a sufficiently healthy condition to mature seed. This fact was proof of its hardiness. He gathered the grain and seeded it in raw, rough ground on August 15. A few spears had pushed through the soil on the 28th, and the growth from that date until the patch was covered with snow proceeded slowly. Apparently every seed germinated, and the rye went into winter quarters in good condition. It began snowing early in October, before there had been any severe frost, and the amount of snow gradually increased with the cold. By the 1st of November the snow was about 15 inches deep, and later in the winter it was increased to 3 feet. This appeared to be a sufficient covering to protect the grain from the severe frost for, although the thermometer is said to have registered more than 70° below zero, the rye was not injured in the least. It came out in excellent condition in the spring. The snow was not a sufficient covering, however, to keep the ground from freez-

ing. Owing to the removal of the moss which enabled the sun to reach the surface of the earth, and doubtless aided also by the tearing up of the roots, the soil had thawed out to a depth of 18 inches by the time the rye was seeded; but in spite of the snow covering, the ground nevertheless froze again during the winter clear down to the old ice.

On May 13, 1901, the snow melted from the plats, and the rye appeared green and in perfect condition. The plants tillered abundantly, sending out from 10 to 18 shoots each. It grew very rapidly. On June 23 it was 2 feet high, with heads showing here and there. On July 20 average stalks measured 5 feet 4 inches high. At that date the heads were filling rapidly. On the night of July 31, there was a light frost, sufficient, however, to kill potato tops and other tender vegetation. But the rye and in fact nearly all of the grains were not injured. The grain was then in the dough state and almost ready to cut. Most of it was cut on August 3. When I was at the station August 13, some of it which had not been cut was perfectly ripe, and it had a good quality of grain.

This then proves that winter rye can be grown in that latitude. Rye is the principal breadstuff in all northern latitudes. Northern people prefer it to wheat, and it is probable that the future farmers of Alaska will likewise make rye a principal crop.

It should be noted also that the past winter registered the coldest weather in the interior that the proverbial "oldest inhabitant" has ever known. The test is, therefore, as severe as it is likely to be at any future time.

SPRING GRAIN.

Patches of several varieties of spring grain were sown in the latter part of May. But I have at this writing received no word from the Yukon since I left the station on August 13 as to whether they matured or not. At that date the barley and the rye were the only grains which had matured. Several other kinds had fully formed grains, and would soon begin to ripen, but having no information concerning their later development I can note only their growth and condition up to the date of my visit. The spring grains seeded were as follows:

Spring rye.—A plat was seeded May 21. By July 7 the plants had reached a height of 18 inches and were showing heads. On July 31 the stalks were 5 feet high and the grain two-thirds formed. On August 13 the grain was fully formed, but still green, and in the soft dough.

On June 5 another plat of spring rye was seeded. The growth was rapid but the stand thin, and the plants did not tiller. July 10 the stalks averaged 20 inches and the heads were showing. July 31 the stalks were 4 feet 7 inches high and the grain forming. August 13 the grain was rather more than half grown.

BARLEY.

Manshury.—A plat of this barley was sown May 23. It was somewhat slow in starting, but when it came up the stand was good and the plants healthy in appearance. On July 12 it was 16 inches high and beginning to head. On July 31 it was 2½ feet high and the grain nearly grown. It was not injured in the least by the frost that occurred on the night of that date. August 13, when I was at the station, it was ripe and ready to cut at any time. The grain was plump, the heads heavy, and quite yellow in appearance. The accompanying illustration (Pl. XV, fig. 1) is a reproduction of a photograph of this patch of barley. It is another proof in addition to the many already on record that barley can be grown very successfully in the interior. The only point to note being that early maturing varieties should be selected.

On June 5 another plat of the same barley was seeded. July 18 it was 18 inches high. July 31 it was 2½ feet high and the grain about half grown. It was not injured by the frost. August 13 the grain was fully formed, but it had not begun to ripen.

OATS.

Burt Extra Early.—A plat of this variety was seeded June 4. It started to grow promptly. The plants were healthy and made an even stand. July 18 it was 15 inches high and had begun to head. July 31 it was 2½ feet high and the grain half formed. It was not injured by the frost which occurred on the night of that date. August 13 the grain was fully formed, but still in the milk, and showed no signs of ripening. This variety has, all things considered, given the best satisfaction of the many kinds tried at the Sitka and Kenai stations. It is not a heavy yielder. The straw is short and the grain small, but on the coast it has matured in time to be harvested before the fall rains set in, as a general thing, and in the interior it will probably prove to mature before killing frosts occur in late summer.

Perm.—A variety of Russian oats imported by the United States Department of Agriculture. The seed used was grown at the Sitka Station. It was planted May 23. It grew promptly and made a good stand. July 14 the plants averaged 16 inches high. July 31 the crop was 32 inches high, the grain almost fully formed, and heads of fair size. It was not injured by the frost of July 31. August 13 most of the grain was still in the milk and had not begun to ripen. It was 4 feet high. I have not heard if it matured.

Another plat of the same variety was seeded June 6, also from Sitka seed. July 19 it was 18 inches high and heading out. July 31 it was 27 inches high and the grain rapidly developing. It was not injured by the frost. August 13 it was in the milk.

Flying Scotchman.—Small plats were seeded of this and also of the

Fig. 1.—Alaska Stations—Ripe Barley, Rampart, August 13, 1901.

Fig. 2.—Alaska Stations—Grass, Rampart Creek.

following variety, but both were too late to mature the past season. It was seeded June 4. July 31 the tallest stalks were 26 inches high, only about half headed, and beginning to bloom. It did not appear to be injured by the frost of that date, but it is doubtful if it matured seed.

Common oats (such as is offered for sale for feed).—A plat was seeded June 4. By July 31 it was about 2 feet high and heading out. It was slightly injured by the frost of that date.

Russian White.—This variety was also grown from seed produced at the Sitka Station. The plat was seeded June 4. July 24 it was 16 inches high and beginning to head. Rather uneven in growth. July 31 the best was 2 feet high and in bloom. August 13 the grain was half grown. This variety is not an early one, and probably not as well suited to this region as some of the others named.

SPRING WHEAT.

Ladoga.—Plat seeded May 29. It appeared slow to start and the plants were not vigorous. July 24 it was 15 inches high and beginning to head. Foliage was rather light in color. July 31 it was in bloom. The heads with the blossoms exposed were injured by the frost of that date. August 13 the heads which were not injured were beginning to fill.

Romanow.—Seeded May 23. July 19 it was 22 inches high and beginning to head. July 31 it was 3 feet high, and some heads had passed the blooming stage; others were still in bloom. Those in blossom were injured by the frost. August 13 the earliest heads had grain three-quarters grown, and it may have matured. The Romanow has been our most successful variety at the Sitka and Kenai stations.

Roumanian.—A plat was seeded May 29. It started slowly, but the young plants were stocky and healthy. July 21 it was 23 inches high and beginning to head. July 31 it was 3 feet high and for the most part past bloom. It was a vigorous grower, and was not injured by the frost. August 13 the grain was fully three-fourths grown. It may have matured.

Another plat of the same variety was seeded June 6. July 21 it was noticed that the earlier seeding was slightly more vigorous. August 13 most of the heads had grain half grown, but it had not caught up with the earlier planting.

The central facts in these grain experiments as far as they are known to the writer at this date, are: First, that fall seeded rye lived through the winter, came out in the spring healthy and vigorous, and produced plump and perfectly matured grain by the beginning of August. Secondly, that barley seeded in the latter part of May matured seed by the middle of August. In last year's report several instances were reported of grain maturing at various points on the Yukon.

CLOVER.

May 23, two plats were seeded to clover, one alsike and the other red clover. The seeds started slowly in both cases, but eventually made a good stand. August 13 both beds were about 9 inches high. The alsike seemed to be slightly the more vigorous. Some red clover was also scattered on ground that had been burned over, but neither cleared of brush nor dug up.

VEGETABLES.

Mr. Jones makes the following report on the growth of vegetables:

A cold frame was sown to lettuce, cabbage and turnips on August 15, 1900, in order to see what they might do. The soil was new and raw and the plants made only a poor growth, and on the whole went into winter quarters in poor condition. When the frame was uncovered May 13, 1901, nearly all of the plants had been eaten by field mice, but a few plants of cabbage and lettuce were still growing. The muslin covering and the snow had been sufficient to protect them against winterkilling. Some turnips sown outside the frame in the fall, and which had no artificial covering but the snow, came through the winter alive, but soon after growth started in the spring they were eaten by insects.

In the spring of 1901 a plat of sandy loam was selected close to the river which was planted to vegetable seed as soon as the soil could be worked. The selection of the ground proved unfortunate, as the unusual rise of the river washed away a portion of the garden, and for nearly a month the surface of the water was almost on a level with the portion which was not washed away. All growth ceased and, with the exception of radishes and lettuce, vegetables on this piece of ground were an entire failure. Later, vegetable seeds were planted in soil well back from the river. Here the flea-beetle appeared in large numbers, and radishes, turnips, and the first planting of cabbage plants suffered greatly from them. Rabbits also visited this patch, and beets, peas, and cabbage suffered in consequence. Such plants as escaped these pests grew rapidly—lettuce, kale, peas, onions, and carrots being worthy of special mention. The soil was worked down to a fit condition for vegetable seeds with much labor, and the result on this land was more favorable than was hoped for at the time of planting.

A large number of persons received seed from the station this year, and many of them report much success with their gardens.

There are a number of good gardens in Rampart this year, Capt. A. D. Williams having one of the best. Captain Williams has been a successful gardener in Alaska for some years, and the present season he has over an eighth of an acre in cultivation. Capt. Alfred Mayo is one of the oldest gardeners in this section of the country and has been very successful in this line.

BUCKWHEAT.

On June 6 two small plats, were sown with buckwheat. Plat No. 1 to seed from Maine, and No. 2 to a Russian variety. The Maine seeds sprouted quickly and produced a good stand of thrifty plants, which had reached a height of 16 inches and was beginning to bloom on July 20. July 26 an average stalk was 22 inches high. Plants were killed to the ground by the frost of July 31. The Russian variety did not start readily and the stand was poor, but the stalks were vigorous and made a rapid growth. July 17 a few stalks were in bloom, and average stalks were 20 inches in height. July 26 average stalks were 28 inches high, with the grain forming. Killed to the ground by the frost July 31.

POTATOES.

A small quantity of seed potatoes grown at Rampart, last year, was obtained, placed in a shallow box, partly covered with sand, and exposed to the light May 1. At the same time a few pounds of outside potatoes were obtained and these were treated in like manner. Both lots were planted May 23. The soil was rather wet and stiff for planting at this time, and the weather continued cold and damp for some time afterwards. The first potato leaf showed through the soil June 16. From that time on growth was rapid. July 15, stalks from native seed showed blossoms, while the other variety bloomed June 24. Frost of July 31 killed the stalks to the ground. Native seed had at this date produced potatoes as large as an egg, while outside seed produced only very small potatoes.

SETTLEMENTS ALONG THE YUKON.

It may be interesting to name the leading settlements along the river and the approximate distances between them, in order to give some idea of the extent of the territory. The distances here given are only approximate and may vary somewhat in either direction.

Eagle City, which is the first town in American territory, is 106 miles from Dawson. It is beautifully located on high ground in a bend of the river near Eagle Mountain, which is an imposing mass of granite rising to a height of about 2,000 feet. This town will undoubtedly be an important one, especially if the projected railroad through the interior should terminate here. It lies on the margin of a large tract of land sufficiently level to be brought under culture. There is a permanent population of some hundreds of people, and Fort Egbert, which is garrisoned with about two hundred soldiers, is located here.

From Eagle to Circle City is a distance of about 175 miles. This town is located in the border of the "Flats," and the region of the immediate neighborhood is treeless. It is likewise a town which is destined to be permanent. It has come into prominence because it is

the nearest point on the river from which the gold fields on the tributaries of the Tanana can be reached. The absence of timber gives the place a somewhat desolate appearance, but it is a thrifty, enterprising town and is constantly growing in population. Probably a large percentage of the vast expanse of level country in that neighborhood can be used for agricultural purposes.

Fort Yukon is located a few miles inside the Arctic Circle, at the mouth of the Porcupine. It is about 85 miles northwest of Circle City. This is an old settlement, having been a trading post of the Hudson Bay Company many years ago, but it has never become an important post. The permanent white population probably does not exceed one dozen persons, and the Indians in the place are not numerous. A reservation for an experiment station was made there in 1900, but the available funds have been too limited to do any work there.

Rampart is a thriving town, some 200 miles below Fort Yukon. There are several hundred log cabins in this place and a few quite good houses. It takes its importance from the proximity of the placer mines on Minook Creek and its tributaries. The country in the immediate vicinity is rolling, but there is considerable agricultural land in the valleys. The vegetation is luxuriant wherever the ground has been cleared. Pl. XV, fig. 2, gives an illustration of the height of the grass in the valley of Minook Creek. The photograph from which this reproduction was made was taken by Mr. Erastus Brainerd.

Tanana, the next settlement of importance, is located about 80 miles below Rampart; it is at the mouth of Tanana River. The post-office is named Tanana. The settlement was originally called Weare, and the trading post of the North American Transportation and Trading Company still bears this name. Fort Gibbon is located here. It was built in 1900 and has a garrison of approximately two hundred men.

The next settlement of importance is Nulato, located about 225 miles below Tanana. Nulato is an Indian settlement of considerable size. There are also a couple of stores and a Roman Catholic mission. The surrounding country is sufficiently level for cultivation. Pl. XVI, fig. 1, is of interest because it illustrates the leading industry of the Indians during the summer months, namely, the catching and drying of fish. Large quantities of salmon are annually caught at various points on the Yukon; the fish are cleaned, cut in halves, and dried on poles, as shown in the illustration.

Anvik is the next important settlement. It is about 190 miles below Nulato. The population is chiefly Indians, but there are also a number of white people and an Episcopal mission. A portion of the town is illustrated in Pl. XVI, fig. 2. From Anvik to Holy Cross is a distance of about 30 miles. This settlement has already been referred to in detail. Some 80 miles below Holy Cross is a little settlement

FIG. 1.—ALASKA STATIONS—FISH DRYING AT NULATO, YUKON RIVER.

FIG. 2.—ALASKA STATIONS—ANVIK, YUKON RIVER.

known as Russian Mission, missionaries of the Russian Church being established here. And still nearer the mouth of the river, in the treeless region, is the settlement of Andreaoffski, a place which is chiefly of importance because it affords winter quarters for the river boats, and the storehouses belonging to the commercial companies are located here. The whole distance from Dawson to St. Michael is nearly 1,500 miles. Besides the places named, there are many small Indian villages, and during the summer many temporary fishing camps are established along the river.

The transportation on the river is carried on by means of a number of steamers, some of which are large and powerful boats with first-class accommodations for passengers in every respect. These boats consume an immense amount of fuel, as it takes great power to propel them against the current. They have sometimes two or three barges in tow. Wood is the principal fuel used, though coal is used to some extent and its use will probably increase with the development of the coal mines along the river. The boat is tied to the bank, a gang-plank thrown ashore, and a number of men carry the wood aboard on their shoulders. There is considerable coal mined on the lower Yukon, which is used for supplying steamers (Pl. XIX, fig. 2).

A telegraph line has been built by the War Department from St. Michael to Fort Gibbon.

FARMING AT DAWSON.

At Dawson I found several persons engaged in raising produce for the city market. The most extensive farmers at that place are two brothers named Morgan. They are American citizens who have tried their luck at prospecting; but although they were fairly successful they prefer farming. Mr. J. A. Morgan, one of these brothers, informed me that he had rented 110 acres of land from the Canadian Government on the west side of the river just across from the city for a rental of 50 cents an acre a year. He has a lease for ten years, with the privilege of buying at the end of that time. The price of land was not to be fixed, however, until the expiration of the lease. He grows vegetables on a rather extensive scale, confining himself to the standard crops, such as potatoes, cabbages, cauliflowers, turnips, radishes, and lettuce. He also grows grain for hay. This year he had 40 acres in oats. These oats were seeded on May 20 and cut for hay early in August, at which time they were almost ripe. It is more profitable to cut the grain for hay than to let it mature. The past season grain and hay sold exactly at the same price per pound, namely, 6½ cents, or $130 a ton. This was Mr. Morgan's first year and, therefore, he did not have all the land in condition for cropping. He was clearing and preparing the rest of the farm for crops the coming sea-

son. His brother had an equal area of land on the same terms, and he planned to follow the same line of work.

Pl. XVII, fig. 1, is a view of Mr. Morgan's house. The fenced portion of the front yard was well stocked with flowers, which were tenderly cared for by Mrs. Morgan, but they do not show up well in the illustration. Pl. XVII, fig. 2, is a view on Mr. Morgan's farm, looking east. The city of Dawson is in the background to the right on the other side of the river. There were numerous vegetable gardens in various places about Dawson, but more particularly on the west side of the river, and all of these did a thrifty business.

Pl. XVIII shows a display of native grown vegetables in the butcher shop belonging to Mr. J. G. Boyd. The list comprises the following: Cabbage, rhubarb, kale, native cranberries, cucumbers, lettuce, peas, radishes, turnips, cauliflower, carrots, and new potatoes, all grown at Dawson, and for sale there in the latter half of August. This illustration simply adds one more item to the already voluminous testimony which we have in regard to the possibilities of the interior of Alaska.

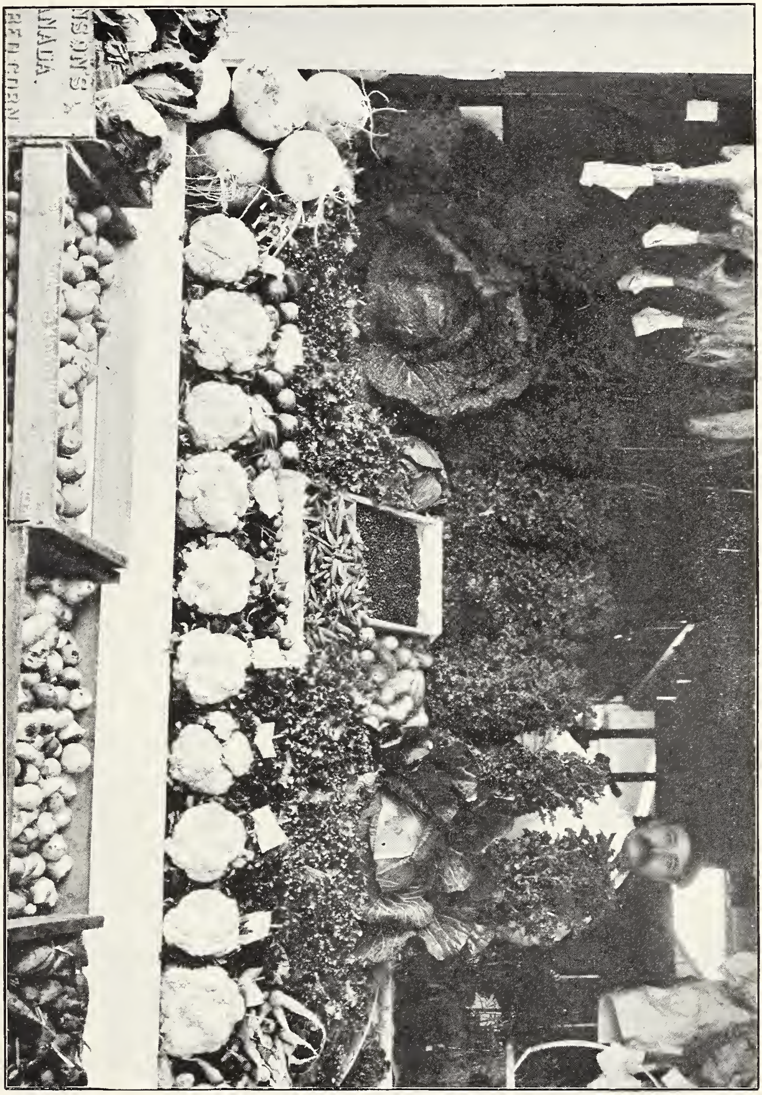
I met the owner of a hay farm which I was told had proved quite profitable. The owner was Mr. Samuel Henry, and his farm is located in the valley of the Stewart River, 25 miles from its mouth. He has 80 acres under cultivation, and he devotes nearly the whole area to hay, which, at the price named above, it can readily be seen is a profitable business.

WHAT OTHERS SEE IN THE YUKON VALLEY.

I submit herewith an article on the agricultural possibilities of the Yukon Valley by Mr. Erastus Brainerd. It is of interest because it expresses the views of a private citizen who has spent years in the country, who by both education and training has been accustomed to look for facts, and who records the facts as he sees them without bias or prejudice on one side or the other. In the course of looking after his interests in the interior, Mr. Brainerd has had occasion to make extensive trips through the country in many directions; he has noted the characteristics of climate, soil, and vegetation peculiar to the various regions he has traversed; he has obtained information from hundreds of prospectors whom he has met; he has studied the results arrived at by other investigators, and he has noted the facts as regards the agricultural possibilities of other countries in the same latitudes and with similar climatic conditions. From this accumulation of data, he comes to the conclusion that agriculture in Alaska is destined to play an important rôle in the development of the resources of the Territory, and that as a matter of course it will also be an important factor in the growth of population and its future history. Of the thousands who visit Alaska there are comparatively few who are as

FIG. 1.—ALASKA STATIONS—FARMHOUSE, WEST DAWSON, YUKON RIVER.

FIG. 2.—ALASKA STATIONS—ON MR. MORGAN'S FARM, WEST DAWSON, YUKON TERRITORY.



ALASKA STATIONS—KLONDIKE-GROWN VEGETABLES DISPLAYED IN DENVER MARKET, DAWSON, YUKON TERRITORY.

FIG 1.—ALASKA STATIONS—VALDEZ, AS SEEN FROM THE BAY, GLACIER IN THE CENTER.

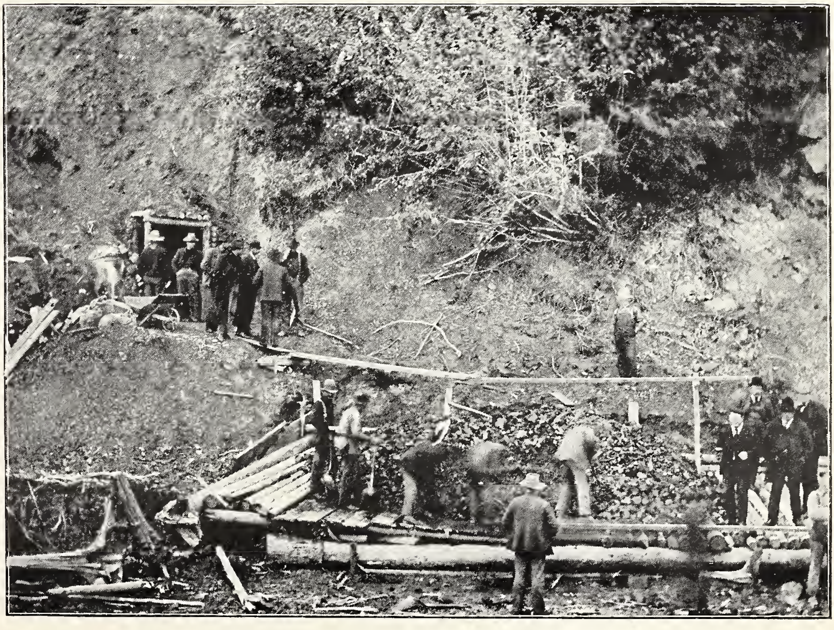


FIG. 2.—ALASKA STATIONS—COAL MINE ON THE LOWER YUKON.

competent to note facts and to interpret them as Mr. Brainerd has done. Most people who go there have preconceived ideas of the country and its possibilities. These ideas have as a general rule been based on the well-nigh universal opinion that Alaska is a barren, useless waste, and they are unable to correct and readjust these ideas so as to conform to the actual facts. Mr. Brainerd's article appeared in the Seattle Post-Intelligencer of September 29, 1901, and is as follows:

YUKON VALLEY FARMS.

Omne ignotum pro terribile—the unknown is a terror—was a common saying with the Romans before the Christian era. So when I went up the Yukon four summers ago and wrote to the Post-Intelligencer that what impressed me most was the luxuriant vegetation, the size of the timber, and the apparent agricultural possibilities, I was not only laughed at by the incredulous, but was asked seriously, "How can anything grow in that terrible frozen region?" Three short years have broadened the knowledge of many, but still the doubters are more numerous than the believers. I hope to show to their satisfaction that the "agricultural possibilities of the Yukon" are neither so visionary as the mirages nor so uncertain as the movement of the auroras which are common in that country, and to-day I present the first photographs that have been made public of actually growing cereals.

Let me first call attention to the fact that it is within the memory of men when the rich and fertile States of Nebraska, Kansas, and Coloradó were marked on the maps as the Great American desert. If the great American desert now blooms with valuable wheat, if not with the beautiful rose, the watersheds of the Yukon may yet be known as the seat of a thriving agricultural community. Of course, the public is becoming familiar with the argument from analogy in the case of Finland, which lies largely in the same latitude as Alaska. It is well known that that country, with only 50,000 square miles of agricultural land, sustains over 2,500,000 people; that at their last report they raised 28,000,000 bushels of cereals, 4,000,000 pounds of flax and hemp, had nearly 3,500,000 cattle and sheep, and exported butter, cheese, oats, and live stock. If a stronger argument from analogy be sought it may be found in the report for 1897 of Alexander Platonovich Engelhardt, governor of the the Russian province of Archangel, which borders on the Arctic, extends to 71° north latitude, and has by far the greater part of its area north of the sixty-sixth parallel.

A MATTER OF ISOTHERMS.

Archangel, its chief town, has nearly 20,000 population, and is in the latitude of the settlement of Nulato on the Yukon. In 1897 the population of the province was 350,000 persons, who in that hyperboreal region raised 60,000 tons of wheat, rye, oats, and potatoes, owned 260,000 cattle and sheep and 280,000 domestic reindeer, and exported over $1,000,000 worth of wood, cereals, butter, and flax. In all the province, Governor Engelhardt says, there are only 216,000 acres of agricultural land and 516,000 acres of pasture land.

But the argument from analogy is often fallacious. If a man were to speak of olives and oranges grown in the latitude of Denver, Indianapolis, or Philadelphia, he would be jeered at by the unthinking, yet that is precisely what is done in California in the latitude of these cities, while apricots and prunes are grown in the State of Washington north of the latitude of Nova Scotia and New Brunswick.

Agriculture is a matter of isotherms and not of latitude, and the isothermal lines in the Yukon Valley, so far as is known, are more favorable to agriculture than those of Finland, for while the winters are colder the summers are hotter. Coming to the

actual climate and soil of the Yukon watershed, let us see what they are, what they are doing for agriculture and can do. The records are incomplete, but they show a high range of temperature which will surprise the uninformed. At Fort Yukon, which is just inside the Arctic Circle, Dr. W. H. Dall, now in the Government service, reported in 1868 that the temperature in July "not in the direct rays of the sun" was 112° F. In June, 1900, the record for the month showed a maximum of 93°, and in July 87°. At Eagle, near the Canadian border, May to August, inclusive, showed a daily average maximum of 79°. Holy Cross Mission, which is less than 350 miles from St. Michael, showed an average maximum for May to September, 1899, of 69°, with a maximum of 82°. The 6-inch soil thermometer at Fort Yukon gave a daily average for June, 1899, of 50.8°, and July gave 54.9°. At Eagle, August gave a daily average of 53° for the 6-inch soil thermometer. The minimum surface temperature during June, July, and August was 25 in August at Eagle, 27 in June at Fort Yukon, and 24 in June at Holy Cross. These minimum temperatures may seem adverse to agricultural success, but the cold was of exceeding brief duration, the soil was warm, and the sun shone almost throughout the twenty-four hours, and the frost though sharp was not killing. Further, it is to be remembered that the points named are most exposed, that Eagle is in the foothills, Fort Yukon within the Arctic Circle, and Holy Cross is subject to the cooling influence of Bering Sea. In other words, the places named are not selected and not the best suited for agriculture.

FIRST EXPERIMENTS MADE.

Naturally the first experiments have been made along "the main traveled road," the great waterway, and while even there the experiments are pregnant with promise, it is in the smaller valleys of the larger affluents of the Yukon that, I believe, the richest future lies. On the verge of the Yukon itself the winds blow up or down according to the season, but in the smaller valleys the wind is still or milder, and the vegetation more luxuriant. This is true of the streams to the north, but much more so of those to the south. Professor Georgeson tells of a great natural meadow some 20 miles long by 4 or 5 wide within the Arctic Circle east of the Koyukuk, and I have been told by reliable persons of a similar meadow on the Dall River. South of the Yukon lies the great valley of the Tanana, which is nearly as long as and has a valley that is wider in places than the Connecticut, the Hudson, or the Sacramento. It rises in the Alaskan coast range and enters the Yukon at Fort Gibbon, 80 miles west of Rampart, and nearly midway between St. Michael and Dawson. In the last half of May, 1899, I made an expedition up the Minook from Rampart and over the divide into the Tanana watershed. The ice still closed the greater part of Minook, and snow was on the ground and the air chill. On crossing the divide the scene shifted. The air was as mild as possible; the redtop grass was as high as my shoulder; lupines and vetches were in bloom, and berries and flowers of many kinds. The creeks were all open, and the season seemed two months ahead of the Yukon. In 1900 the Yukon broke up at Rampart in the third week of May, while the Tanana broke the second week in April. During winter rain never falls in the Yukon. On the Tanana it rained, to my knowledge, in December, 1899, and in January, 1901. It is in this valley that I believe agriculture and stock raising will be found most practicable. Speaking of stock raising, Captain Abercrombie, of the Army, lost a horse in the Tanana Valley in the fall of 1898 and found it well and hearty in the spring of 1899, and a miner named Green, who worked for me last winter, had the same experience in the winter of 1900. At Holy Cross they have a herd of five cattle, four of which are native born, and all are well nourished on native grasses, while horses have wintered and worked all winter on mixed feed and native hay during the past four years at Eagle, Circle, Rampart, and Fort Gibbon. I owned a cayuse which was worked hard all winter, had no covering for protection in the coldest of weather, and is fat and hearty to-day, although the thermometers all failed to

register the extreme cold of last winter, which was estimated at 70° to 80° below zero.

The summer months are rainless, or nearly so, but the soil is moist and cool, while the nights are bright and warm, a condition that is most favorable to steady plant growth. I see no good reasons why carefully selected seeds should not be found that will be adapted to the climatic conditions. In fact, so far as known the climate does not affect the seeds adversely and the winter does not kill them. While the temperatures that I have noted above are average, it must be remembered that the heat during the day in the direct rays of the sun is intense. On July 4, 1900, I noted the thermometer at the Alaska Commercial Company's store at Rampart to be 110°, while this year at Nulato on July 24, at midday on the river, it was 117°, and I have noted above that Dr. Dall found it at 112° at Fort Yukon. With temperatures like these it is reasonable to assume that the climatic conditions of a great part of the Yukon watershed will surely be found favorable to the growth of rapidly maturing, hardy cereals.

That the soil of the Yukon in itself should be capable of producing almost any useful article of vegetable food should be obvious to even a careless observer. Few seem to remember that the great river heads in the Rocky Mountain range; that the Pelly, the MacMillan, the Stewart, and the Porcupine are to the west side of the range what the Milk, the Yellowstone, or the Missouri are to the east side; that the same influences which have carried vast volumes of silt to form the richest alluvial valleys in the United States have operated similarly on both sides, and that the rocks whose decomposition have led to forming the alluvium are the same in the case of the Yukon as in that of the Mississippi; that the volume of the Yukon is greater than that of the "Father of Waters," and that the deposit of the sediment is made in the same way. There can be and is no real question as to the richness of the soil of the Yukon Valley. The only question of importance is, "What can it be made to grow?"

FACTS, NOT FANCIES.

The proof of the pudding is in the eating, and I propose to recite briefly what has been done, basing my statements on those of Professor Georgeson, special agent of the United States Department of Agriculture, and on my own observation, which both complements and supplements that of Professor Georgeson, as I have been over the same ground on the Yukon that he has been, and more. The statements are supported by photographs, which are the first yet taken and made public of the work of the United States agricultural experiment station at Rampart, and of the work of the Jesuit Fathers at their Holy Cross Mission at Koserefsky, on the Yukon. The photographs were taken at Rampart on July 13 and at Holy Cross on July 28, 1901.

Dawson, the best known point on the Yukon, the capital of the well-known Klondike region, is, of course, in Canada. It is well up in the foothills, and has an elevation, I believe, of 2,000 feet above sea level, yet I have seen in Dawson, at their chamber of commerce, fine samples of ripe barley and oats, which Professor Georgeson also saw, and I was told that wheat had been ripened on the Klondike River itself. At Fortymile, near the border, I was told by so many different persons, some of whom I know to be credible witnesses, that I believed them, that an old settler named Patch, so long ago as 1891, raised potatoes for sale, and also had matured samples of wheat and oats. At Eagle this summer, in June, I saw barley and oats growing. Professor Georgeson saw them headed out on July 6, 1900, and later received ripe seed and a head of ripe wheat as well. At Eagle, as at nearly every other point on the river, the Jesuits have fine root crops, growing potatoes, turnips, cabbages, and cauliflower, beside what the Yankees used to call "garden sass," lettuce, radishes, cress, and the like. Circle City was founded ten years ago, and while the country round about is wet, oats have ripened there for at least three years. At

Rampart, in 1895 and 1896, a Norse miner named Peterson, who died last winter, raised cabbage and potatoes successfully on what is now a mining claim on Little Minook Creek, a tributary of the Big Minook, which enters the Yukon at this point. In the summer of 1900 there were several successful gardens at Rampart. Last year Professor Georgeson established an experiment station with Mr. Isaac Jones, a graduate of the Kansas Agricultural College. Single handed, and with mattock and spade alone, Mr. Jones cleared the ground, stripping the moss and grubbing roots from about a half an acre, which was planted with wheat, rye, oats, barley, buckwheat, turnips, and potatoes.

RABBITS DAMAGE CROPS.

Rabbits caused some damage to his crops, but the way they looked on July 13 of this year may be seen in the photographs better than from description. It should be said that the most successful growth was of rye, which was seeded from a few heads of ripe volunteer grain found by Mr. Jones on August 15 of last year, growing in the rear of the North American Transportation and Trading Company's store at Rampart, where the seed had evidently been dropped the season previous from a sack of feed. All this grain was sown in the fall, and as last winter was the severest known on the Yukon, it is evident that seed at least will survive the hardships of a Yukon winter. Mr. Jones's poorest crop was Siberian buckwheat, sown from seed supplied by the United States Department of Agriculture. Some buckwheat of unknown origin did much better, and both were in flower when I took the photographs. The rye, barley, and oats made a fine stand, but wheat was not well on. The soil at this point was a clay loam, with some sand, located about a furlong from the present river bank. The grain was far enough along to indicate that it would be ripe before the hard frosts would naturally set in. At Fort Gibbon, at the mouth of the Tanana, on the north fork of the Yukon, Mr. Georgeson saw and picked oats that were ripe on August 4, 1900. They were part of a patch of volunteers, most of which had been eaten down by the cattle of the fort, but had headed out in second growth and were in bloom. At Holy Cross Mission the Jesuit Fathers, under Father Raphael J. Crimont, a learned, accurate, painstaking, and systematic worker, have made greater progress in farming than at any other point. They have a herd of cattle, all but one native born, fed wholly on native grasses. There are over 3 acres in garden and grain this year. On this they have raised over 500 bushels of Early Rose potatoes on less than two acres. Most of the potatoes are small and not mealy, but they are good, and the largest weighed 17 ounces. They have raised turnips weighing $8\frac{1}{2}$ pounds, and beets and carrots weighing over $\frac{3}{4}$ of a pound each. This year, for the first time, they planted grain which was supplied by Professor Georgeson, and I give photographs showing how it looked on July 28. The soil at this point is not very good, and it was prepared without suitable implements.

MOST CROPS FLOURISH.

It is true that "one swallow maketh not a summer," and there is no reason to think that the farms of the Yukon will ever rival the bonanza wheat fields of Dakota; but it is equally true that wheat, oats, rye, and barley have ripened and produced mature seed at different points during several years under the most adverse circumstances on the Yukon. It is also true beyond peradventure that most crops and nearly all garden vegetables grow to perfection wherever the ground is scratched, and that currants, raspberries, gooseberries, cranberries, huckleberries, and many other native small fruits do exceptionally well. It seems reasonable to conclude, therefore, that time and attention will show that ordinary agricultural operations can be carried on successfully, more so than anyone would have believed four years ago, and more than the great American public yet realizes. It will amaze most people

even now to learn that the careful estimate of Professor Georgeson, the Agricultural Department's expert, who has personally been over the ground, is that Alaska contains 100,000 square miles of tillable and pasture land and that "it is chiefly the vast region in the interior" which will furnish the agricultural land. In this estimate I believe he is correct. I have spent much more time than he has in the country, have traveled the river from source to mouth, and have made it a point to question the majority of the miners and explorers whom I have met, certainly at least a thousand and probably more during four years, men who have been on nearly every creek and river of the Yukon watershed, the Porcupine, Koyukuk, Tanana, White, Shageluk, Melozi, Novi, Dall, Chandeleure, Chena, Nenana, Ozanna, and others, some not yet mapped, and while neither their testimony nor mine is expert, and while some were skeptical, by far the greater number believe that some day the Yukon valleys will be settled by small farmers, particularly by the sturdy Norsemen, men who as Professor Georgeson suggests, "possess the courage to face and sufficient energy and strength to endure the hardships incident to pioneer life in a northern climate, who can clear and till the land with their own hands." Such men, who do not look for a market, but for a home where they can support themselves in independence, will eventually find it in the Yukon Valley, where by a little farming, some fishing and hunting, and some mining they may be happier and more comfortable than they are now. In fact, there are a very few such persons there now. I know personally an Englishman and his wife who have located a farm on which they are already self-supporting and where they expect to end their days.

I have mentioned fishing as incidental to farming, for the wealth of fish in the streams is almost incredible even to a resident of Puget Sound, where the salmon canning industry is so vast. As an indication of what it is I give a photograph of salmon drying at one Indian village, Nulato, where the fish are caught by the most primitive methods. I have mentioned none of the drawbacks, for they are only those incidental to pioneering. Isolation, cold, and insect pests, mosquitoes, and gnats. These are bad, but I believe they are no worse than the Pilgrim Fathers found when they first landed on the "stern and rock-bound coasts" of New England. There the cold was more intense because it was damp, the mosquito plague at first as bad, and the isolation greater, because the Pilgrims were months from civilization where the Yukon pioneers will be weeks, while with the Government telegraph line now building completed they will not be days from touch with the rest of the world.

EDITORIAL COMMENTS.

The same issue of the Post-Intelligencer which contained the foregoing article by Mr. Brainerd, namely, that of September 29, 1901, contained also an editorial on the general subject of agriculture in Alaska, which I submit because it shows that the leavening forces of investigation and education are at work and because it aims at the correction of misleading conclusions, drawn from faulty premises, but which have been widely disseminated throughout the country. The fact that but few men make their living in Alaska by agriculture at present should not be taken as proof that the country has no agricultural possibilities. The editorial is as follows:

The publication of a little bulletin by the Census Bureau, dealing with agriculture in Alaska, has led to an amazing amount of uninformed comment by newspapers of the country. One would have supposed that even the most careless newspaper writer would know that census investigations deal with facts as they are and not with facts that may or may not exist hereafter. One would not expect the statistics

of an undeveloped industry in an undeveloped country to be taken up and commented upon as a measure of that country's capabilities and a statement of its limitations in that especial direction. Yet that is just what has happened.

The same dogmatism of ignorance that once condemned the central spaces of this continent, now the home of millions of thriving people, to desolation, tells us that farming can not be carried on in Alaska.

We have taken occasion several times to correct the ludicrous but injurious conception of Alaska's future thus set before the people by agencies to which they are accustomed to trust for facts. We have, in particular, pointed out the conditions of climate along the already well-known coast region of Alaska, the modifications produced by the warm Japan current, and the certainty of profitable returns on agricultural industry there wherever there are reaches of lowlands suitable for cultivation. But it will be novel to most of our own readers to hear that the agricultural possibilities of interior Alaska, especially of the valley of the Yukon and its tributaries, are even greater than those of other sections. For here we have the splendid alluvial soil that characterizes the river bottoms of our own mountain regions, while the climate is such that almost all the products of the north temperate zone may be raised there with certainty and in abundance.

This fact is set forth in an extremely interesting and valuable article by Mr. Erastus Brainerd, which appears elsewhere in this issue. Mr. Brainerd is not talking theory, but fact. He is a man who sees things as they are and understands what he sees. He writes of a country with which he is personally familiar. He tells what has actually been done as well as what is possible. And his statements are reenforced by a series of photographs, taken on the spot, which may convey a few new conceptions to those in the East who have formed their ideas of Alaska from a view of the Muir glacier.

Mr. Brainerd says: "Wheat, oats, rye, and barley have ripened and produced mature seed at different points during several years under the most adverse circumstances on the Yukon." He says that most crops, and nearly all the vegetables, with small fruits, grow in the greatest profusion with but little care, while there is no question of the value of the section as a stock-producing country. This is substantiated by the facts of past experience, and is to be considered in connection with the estimate of an expert of the Agricultural Department, that there are at least 100,000 square miles of tillable and pasture land in Alaska, chiefly in the interior.

The analogy of other countries lying as far north as the Yukon, or farther, referred to by Mr. Brainerd, makes the estimate of Alaska's future agriculture primarily reasonable. Its possibilities rest mainly on two conditions which are entirely overlooked by those who have never lived beyond the lower latitudes. One of these is the high summer temperature, the other the length of the summer day. The attention of the outsider is directed wholly to the excessive cold of the Alaskan winter. He hears of 70° and 80° below zero, and forthwith assumes that the thermometer barely rises above the freezing point in summer. The fact is that a temperature of over 100 is not uncommon, while the average for the short summer is high.

We say "short summer," but that needs qualification. It is short in months and days, but long in hours. When the sun is farthest north, there is, in those latitudes, a period of but from two or three to five or six hours of twilight. Plant life, looking for light and heat, gets as much of them in two months of these lengthened days as it does in four months of the days farther from the Arctic Circle. The working of the law is perfectly familiar to the farmers of Minnesota and the Dakotas, where cereals mature in much less time than farther south. The Alaskan valley, during the brief warm term, is a veritable hothouse, where vegetable growth proceeds by a forcing process to results impossible elsewhere in the same length of time.

All the circumstances, all the experience of men elsewhere, as well as in the few spots of Alaska which the hunt for gold has permitted to be devoted to agricultural

uses, all the well-known physical laws of the seasons and of the germination and development of plants, point unmistakably to the conclusion that Alaska will one day support a large population engaged in tilling the soil and in the care of herds. It may take long to develop, but the immigration induced by gold discoveries will hasten it wonderfully. Meanwhile it is important, and it is just that a true idea of Alaska should be set before the people instead of that which ignorance and superficialism have caused to prevail, even among intelligent men.

REPORT OF ISAAC JONES ON THE RECONNOISSANCE OF THE INTERIOR ALONG THE TRAIL FROM EAGLE TO VALDEZ.

The following report on that portion of Alaska bordering on the mail and Government trails between Eagle and Valdez is respectfully submitted:

I started from Eagle on the morning of September 10 in company with Mr. Oscar Fish, the mail contractor, and one of his carriers, Mr. Al. Paxton. The trail, which is simply a more or less well-marked footpath along which pack animals may be taken, leads off in a southwesterly direction from Eagle to the ridge, which on one side is drained by the Fortymile system, and on the other by tributaries of American and Mission creeks.

The trail here is very good as Alaskan trails are considered. On the lowlands and through the timber the soil is somewhat sandy in character and fairly well drained. Trees that would have interfered in using pack animals have been removed, and it is only where there is a very considerable depth of moss that the trail is wet and at all trying on horses. On the higher ground the trail has very much the appearance of the buffalo paths that used to be so common in the prairie States. It is beaten well below the general level, and has the characteristic windings where there seems to be no good reason why it should not have continued in a straight course.

For 25 miles from Eagle the entire country is broken by small creeks, separated from one another by steep ridges. These streams have, as a rule, very narrow valleys. The hillsides are steep, and in nearly all cases the foot of the incline is close to the stream. In places, the higher ground spreads out in a sort of table-land half or three-fourths of a mile wide; but generally the distance across is not nearly so great, and in some places the ridge is sharp and stony. This hill country is said to have an elevation of from 2,000 to 3,000 feet. The soil in places is a clay loam, usually wet, but more often it is made up of disintegrated granite or slate, and in this section good-sized pieces of the rock are much in evidence.

This portion of Alaska has little to commend it to the agriculturist except perhaps as a grazing country. In general, there is a heavy coat of moss on the surface, but in some places a native grass (commonly called redtop) has asserted itself and would furnish considerable feed for stock.

Throughout this section trees of spruce, birch, alder, poplar, and several varieties of willow constitute the timber growth, spruce and birch being more common than the other kinds. Spruce and alder make rather dense growths on the lower lands, and a spruce tree 14 inches in diameter at the butt is not uncommon. Specimens of alder 25 feet high, and with a 4-inch diameter at the ground can be found all along the streams.

Poplar and birch are commonly found on the sidehills, where the growth is somewhat sparse. Six inches is probably above the average diameter for birch, and the largest poplars in this section have no more than a 10-inch diameter, though in other places trees of this species 20 inches in diameter may be found. In general the lower portions of the hillsides are heavily timbered; the growth becoming less dense as you reach higher ground. The timber land is usually about two-thirds the distance from the creek bed to the hilltops, varying as the slope is north or south. Dwarf birch is common on the highest levels, and patches of scrub willow may be found on very high land. On the highest elevations these dwarfs are very little taller than the bushes of blueberry (*Vaccinium canadense*), which are very common and which bear abundantly. Cranberries (*Vaccinium oxycoccus*) and bear berries (*Arctostaphylos uva-ursi*) are also very common at this season, and may be found at any point from the creek bed to the summits of the highest hills.

At a point about 25 miles from Eagle the trail leads downward, and for several miles passes over a gradual slope which extends from the high ground to the bed of Liberty Creek and as far up and down stream as one can see from the trail. There is about 30 square miles of land here that from the slope of the surface and the character of the soil should be considered very desirable for farming. The slope faces the southwest, hence has a good exposure to the sun. A portion of this slope has been burned over in recent years, and on the land thus cleared of moss very fine native redtop was growing. On patches here and there the stand of grass was thick enough to yield a good crop of hay, and the entire slope would supply good pasturage for live stock.

The soil of this slope is a sandy loam, well drained and generally of good depth, though occasional gravel spots may be found. Portions of the slope are covered by a dense growth of young spruce trees 4–6 inches in diameter. In other parts the timber is sparse. There are few growing trees of large size, but many large trees that were killed by fire a number of years ago may be seen.

The land rises quickly on the south side of Liberty Creek, and after about five hours' travel over hill country we pass to the left of a landmark of note called "The Dome." This elevation is hemispherical in form, and with a very regular outline, considering that the rock

belongs to the slate family. It rises high above the surrounding country, and has an altitude of 4,600 feet. "The Dome" is used as a sort of official guide for travelers through this portion of Alaska, and trails to different sections intersect close to its base. Our camp on the evening of September 11 was close to the "The Dome," and some 35 miles from Eagle.

On the morning of September 12 two of our horses were missing. Several hours' search failed to find them, and Mr. Paxton remained to continue the search, while Mr. Fish and myself proceeded on toward Fortymile. The trail led over a hill country, but the slopes were in general less steep than the hillsides north and east of "The Dome." The slopes here are covered with heavy spruce timber almost to the hilltops, and the trees of poplar are also of good size.

On the evening of the 12th we crossed the Fortymile and stopped at "Pete's Place," at the mouth of Steele Creek. There is no extent of valley to the Fortymile at this point. The banks rise high and rocky above the stream. This flat is closely shut in by high land on all sides, and is seemingly not well placed for a garden spot, but the persons that had planted garden seeds were well pleased with the result. I saw a patch of very good oats that had grown in one of these gardens. The seed was sown in June and it stood 3 feet 6 inches high with well-filled heads of fully matured grain when I saw it in September. We are now in the gold-bearing section of the Fortymile system, though no great amount of gold has been taken from Steele Creek.

On the morning of the 13th a heavy fog prevented one from observing any extent of territory. The mail trail runs somewhat parallel to and above "Jack Wade Creek" for some distance, the creek being on our left and the trail going toward its source. The miners travel the mail trail to and from Steele Creek, and it has happened that travelers who did not know the country have made the turn off to the left into Jack Wade Creek, instead of keeping the main trail toward Franklin Gulch.

Jack Wade Creek and Franklin Gulch are both gold producing, the output each year being considerable. There is no land through this section that would appeal to an agriculturist. The hilltops are stony, the sides are somewhat boggy, and, as far as I could judge, the timber is not good. Mr. Fish has a relay station (a place where horses are changed and provisions secured) at Franklin Gulch, and the carrier who handles the mail between Franklin Gulch and the Tanana station was our traveling companion until we reached the latter place, some several days later.

The mail man is welcomed in all portions of Alaska, and Franklin Gulch is no exception to the rule. Men from the lower claims come to the mouth of the creek in hope of receiving mail or to hear the latest news from the "outside," the mail to be delivered en route

being carried outside the sack. Here I met Mr. John Martin, a pioneer of Franklin Gulch, who is noted throughout the Fortymile country for his hospitality.

The South Fork at Franklin Gulch is neither as deep nor as swift as the main stream of the Fortymile. At Steele Creek we and our goods were ferried across, the horses swimming the stream; but here the horses could wade without difficulty.

Leaving Franklin Gulch on the morning of September 14, we traveled in a southwest direction toward the Upper South Fork. The change in direction of the South Fork, from a northeast to a straight north course, occurs several miles above Franklin Gulch at a point where Walkers Fork comes into the South Fork. From the high points on the trail we could see that above this junction of Walker's and South Fork both of these streams flow through comparatively wide valleys. Along each of these streams is a considerable strip of grass land, close to the stream. In general the grass is distributed on both banks, but it may be mostly on one side or the other, according to the winding of the stream across the valley. These strips of grass land, not more than a quarter of a mile across at the lower end, widen with the valley as you go upstream. After about 10 miles of hill lands the trail leads to a somewhat low rolling country, with gradual slopes. There is a dark sandy loam here, some three inches deep, with a clay subsoil that prevents good drainage, and in consequence there is much water on the surface. This is a good grazing country. The timber, which is mostly spruce and of good size, is not of dense growth.

During the afternoon we passed close to a bend of the South Fork, which is on our left, and for some distance through a very fine patch of redtop, growing close to the stream.

On the evening of the 14th we crossed a small stream called Gold Creek, and stopped for the night at the mail cabin at this place. Gold Creek flows through a valley, the soil of which is largely made up of disintegrated granite. Creek gravel is found in different places on the lower land, an indication that the stream is not always confined within the low banks. Very fine specimens of spruce and cottonwood are growing here. The mail cabin, which is roomy and well made, was built for Mr. Fish by an Indian.

Next morning, the 15th, we traveled for several miles over a somewhat heavily timbered country, mostly spruce, and having a limestone soil. About 10 a. m. we passed from the timber to a grass covered level plain, having a sandy soil. The grass land is about 8 miles across at this point, increasing in width as you go upstream of South Fork of the Fortymile. There are some small patches of "nigger heads" (bunches of swamp grass which year by year form a compact tuft of roots that is several inches above the original level), but

most of the land is well drained, and on this a heavy crop of native grass was growing. Our stop for lunch was at the Indian village of Ketchumstock. This village is located well out in the grass country, and away from all timber. The town is divided by Ketchumstock Creek, which runs southeast into South Fork, and is used as a means for transporting firewood and house logs for the village. The Indians in this tribe are somewhat lighter in complexion than the Yukon Indians, and some of the older men wear long, rather heavy beards. The chief takes great pride in an American flag, which floats from a very respectable flag pole while visitors are at the village. These Indians do not appear to be particularly resourceful, though cabins recently built are a decided improvement over the older buildings in the village. They cross the stream that flows through the village by means of a rude raft. The stream is neither wide nor deep, and could easily be bridged. That the raft does not handle easily, and that it does not always carry the passenger safely to the opposite bank of the stream was, I think, very forcibly impressed upon the mind of a certain member of our party, who got a cold bath while crossing.

In the timber that skirts this grass land the Indians have built a fence that represents considerable time and labor. I have been told that there is over 60 miles of this fence, which is about 6 feet high, and which somewhat resembles the worm fence of certain sections in the States. The fence is built by first laying a row of poles on the ground and then driving stakes on both sides in a slanting position, so that they will rest on and cross above the pole used as the bedpiece for the fence. The forks thus formed are tied with willow withes; the second pole rests in the forks. Other stakes are driven in a more upright position, so that they cross above the second pole, and so on until the fence is finished. Between the forks, if the poles are long, stays are placed in the ground in a perpendicular position, and each pole is tied to the stay. Snares are set in the openings in the fence, and many caribou are taken in this way. There are about 50 Indians in Ketchumstock. This village is located about 110 miles from Eagle and 320 miles from Valdez. During the afternoon of the 15th we continued across the flat country, part of which is very wet, but not at all muddy. We passed through some meadows over which a mowing machine would work without difficulty. On these meadow sections the grass grows tall and heavy, and the entire flat affords excellent pasturage.

Our camp on the evening of the 15th was at the Indian Creek cabin. The cabins between relay stations have been repeatedly robbed of provisions during the summer months, and for this reason we carried supplies from one relay station to the next, no supplies having been placed in the intervening cabins for the summer season. In some way the sack containing our flour, oatmeal, etc., was left outside with the

saddles, at the Indian Creek cabin, and next morning we found that the horses had made a clean sweep. For two days now, or until reaching the relay station at Tanana, bread and mush were omitted from our bill of fare.

Indian Creek is little more than a brook flowing through the grass country; there are patches of spruce timber in places along close to the banks. We crossed this stream on the morning of the 16th, and passed over some very wet country, a great deal of which is niggerhead land. There are evidences of peat formation here. In places fire has burned down 3 or 4 feet below the level; these holes usually are not more than 20 or 30 feet square, and have a soft sticky red clay at the bottom of the pit.

The dry lands between Indian River and the Mosquito Fork, which is a continuation of South Fork, and which we crossed just before noon, somewhat resemble the prairie soil of the Central States. There were patches of very heavy growth of redtop. According to the measurements of a Government party that had passed over a portion of this trail in running a line from Valdez to Eagle, the point at which we crossed the Mosquito Fork is 303 miles from Valdez.

We had a much drier trail during the afternoon of the 16th; we were gradually going up grade across a grass country dotted with patches of scrub willows and small spruce trees. Grouse were very numerous here, as they are the entire distance to Copper Center, 200 miles farther on. The surveying party had marked the distance from Valdez on at intervals of 5 miles wherever a tree could be found for a mile post, and these posts are looked for with interest, though it sometimes happens that one is passed without being noticed.

When we reached the cabin at Wolf Creek on the evening of the 16th we had practically crossed the Ketchumstock Flats. I estimate that there are at least 750,000 acres of excellent grazing country in the valley of the Upper South Fork and its tributaries. About half of this area is sparsely timbered, but is still good grazing land. One can obtain a good idea of the extent of the grass lands from a point a little north and east of Indian Creek; from here the treeless region stretches out for miles in all directions, and seemingly well up the sides of the low hills that almost surround it.

Much of this land could be brought under cultivation as easily as prairie lands of the Middle West. As a money making proposition there is no inducement for one to try farming in this section at the present time; there is no mining camp of importance near, and there would be no market for surplus products. Game is plentiful, however, and the man in whom the spirit of the old pioneer is found might be well pleased with the life he might live here by combining farming, hunting, and prospecting for gold or other minerals. Again, I think stock might be raised here at a very considerable profit; any desired

quantity of hay could be put up for the winter use, and when ready for market the animals could be driven to Dawson or Eagle and shipped in barges to points along the lower river. Perhaps the easiest route to this section at the present time would be from Fortymile Post up the Fortymile trail to Steele Creek and then over the trail we traveled.

Horses have lived through the winter in this grass section on more than one occasion. A Mr. Anderson, of Steele Creek, has a black horse that was taken up last spring after having spent the winter on the Ketchumstock Flats. The Indians told of two horses that were turned loose by a Mr. Holeman in the fall of 1899. These animals have passed two winters in this section, and were seen a few miles from the trail two days before we passed the village.

On the morning of September 17 our path was one of ups and downs, each succeeding grade taking us to greater heights. Just before noon we reached the summit of the divide between the Fortymile and the Tanana Rivers, and we ate lunch some distance down on the Tanana side. Judging from the vegetation, frosts are several days earlier on the Yukon than on the Tanana side of the divide.

Before leaving Eagle I noticed that the leaves of the cottonwood, birch, and alder were highly colored, and had begun to fall. On the Tanana side the leaves of these trees were still green. None of the vegetation showed the least injury from frost. I gathered some very good raspberries here; the berries had evidently been ripe for some time, and though the flavor was good it would have been better had the berries been gathered at an earlier date. The raspberries here differ somewhat from those on the Yukon. Here the bush stands erect and tall, and the berries do not drop immediately after ripening, which is the case with the Yukon variety, the bushes of which do not make an erect growth. Good specimens of spruce and cottonwood are growing well up toward the summit on the Tanana side, the growth being dense in places.

The slope on the Tanana side is much steeper than that on the Fortymile side of the divide. Early in the afternoon we reached the lowlands of the Tanana Valley. For 6 miles the ground is deeply moss covered, and small patches of nigger-head land are passed over. The timber is only fair until we approach Lake Mansfield, where the individual trees are large. This lake is a beautiful body of water, circular in outline, and about 3½ miles in diameter, and having a sandy shore. Water fowls were plentiful and the lake is said to be well stocked with fish. The Indians set traps in the outlet, on the south side of the lake, and large numbers of white-fish are taken in this manner. The salmon does not get up this far. From Lake Mansfield to the station on the Tanana, a distance of 8 miles, the soil is a brown sandy loam, with a sandy subsoil. In general the timber growth is not dense,

though large trees are plentiful, and there are some patches of dense young growth. Close to the river the timber is very good.

There is some good hay land here. I saw some excellent hay that was put up for the mail horses by Mr. Charles Overheiser, who had been in charge of the Fish Brothers' trading station at the Tanana. Grass has not taken this section as it has taken the ground in the Fortymile country, or as it is said to have taken the land lower down on the Tanana. Straggling bunches of grass are found all over the valley. A very thin coat of moss covers the ground, and blueberry bushes make up the undergrowth for a great part of this section.

There are two large log buildings at the Tanana, both belonging to Fish Brothers. One is used as a warehouse and general store, and the other, which was not finished when we passed, will be used as a road house. At present there are no other buildings at this point. The goods for the store are hauled from Fortymile Post on the Yukon during the winter. Next season an attempt will be made to get a small steamer to this point, some 350 miles from its junction with the Yukon. At the Tanana station we are 265 miles from Valdez, and about 170 miles from Eagle. There is a free ferry at this point, which is looked after by the man in charge at the station. This ferry is a great convenience to prospectors or others that pass this way during the summer months. Of course the horses have to swim the stream, which is said to be 500 feet wide at this point, but the boat enables the traveler to keep himself and his outfit dry while making the crossing.

There is a large stretch of almost perfectly level land on the south side of the Tanana. The soil is a dark sandy loam and the subsoil is sandy. I made a reservation of a square mile on the south side of the river, the northwest corner being close to the river, and near the Government trail, which has been cleared of brush to the Tanana. As far as one can see up or down stream from this point, probably 15 miles in each direction, there is no closing in of the valley, and it is at least 20 miles wide here. A large area in this portion of the valley was burned over some years ago. But outside this burnt area, where timber is still alive, there is no underbrush to speak of and the timber generally is small and somewhat scattering.

This land can be brought under cultivation with little difficulty. It is possible, however, that the rainfall in summer is not sufficient for growing crops. The sandy nature of the soil would prevent its retaining moisture for long periods. I was unable to obtain definite information as to the rainfall, but I am satisfied that, barring dry weather, farming may be carried on successfully in the valley of the Tanana. As in the Ketchumstock country, there would be no market for farm products at the present time.

Captain Abercrombie's force of trail makers had reached the Tanana, and turned back a few days before we reached this point. Trail build-

ing across the valley of the Tanana is comparatively easy, as all one need do is to remove the windfalls that may lie across the proposed road, and in some places standing timber has to be removed also in order to get the required width, 12 feet, for the trail. Before reaching the Tanana Valley the task of the trail makers was not an easy one, but the capable manner in which the difficulties that presented themselves were surmounted showed that the men understood their work.

Leaving the Tanana Valley, our course is up the valley of the Tok, in the direction of Mantasta Pass. This valley is several miles wide, and has in places a clay soil very wet. In other parts the valley is stony. There is no agricultural land here, but there are some beautiful specimens of spruce and cottonwood. In crossing the Tok at a point where it seemed necessary to partly unpack the horses, the water being deep and swift, another member of our party had reason to know that Indian rafts are not a safe means of transportation for one unskilled in handling them. When we reached Mantasta cabin on the evening of the 19th, we had crossed, or were then at the summit of, the pass. The lake which lies just south of the cabin is stocked with fish from the Slana River, a tributary of the Copper River. The grade from the valley of the Tanana to this point has been so gradual that it is difficult for one to believe that he has reached the highest point on the trail, between the Tanana and Copper River valleys. Sharp-pointed peaks that rise to a great elevation on each side of the pass convince one that the trail from the coast to the Yukon would have been a difficult one had not nature provided this pass. At Mantasta cabin we found the trail builders; they were camped here for the night. They had no grain for their horses, and were compelled to travel by short stages so that the horses might have more time to feed.

On the morning of the 20th our trail was rocky, in the literal sense, taking us over several miles of cobblestones of granite. Early in the afternoon of the 20th, we reached a point from which the broad valley of the Copper River could be seen, and towards the evening of the same day we saw the stream itself off to the left. We camped outdoors on the bare ground, not having a tent, on the night of the 20th. The mail cabin is some two miles from the Government trail. During the afternoon of the 20th, and all day until the evening of the 21st, we traveled over a slightly rolling country, which was deeply covered with moss, and upon which the timber, mostly spruce, was of small size except close to the streams, and not of dense growth anywhere. Through this section there are many small lakes having small streams as outlets. Nigger-head land is also very common here, and there are certainly many areas of considerable size in Alaska in which agricultural possibilities are more favorable.

The Chestochena River near the mouth spreads out in several channels, over a very wide bed. These shallow channels are constantly

changing, as are also the channels of the Copper, which spread over a wide river bed at this point. The relay mail station is on the south side of the Chestochena River, close to the bank of the Copper, and at the junction of these two rivers. This point is on the route from Valdez to the gold diggings at the headwaters of the Chestochena, some 60 miles to the northwest, and the mail contractors maintain a trading post in connection with the relay station, with Mr. Harry Fane, who also acts as mail carrier between the Tanana station and this point, in charge. This station is 160 miles from Valdez.

South of the Chestochena station the soil has a depth greater than that on the north side of the pass, and here the valley of the Copper is largely made up of broad level benches, that rise one above another as one goes back from the river. Some of these benches are somewhat sandy and probably would be rather dry during the summer months; others would retain moisture for a long period. Prospectors speak with enthusiasm of fine farming lands toward the headwaters of the Gakona and Tazlena rivers, and there is good land near the mouth of each of these streams.

The Gakona is some 200 feet wide, and is crossed by a ferry for men and goods, while horses have to swim. This is a difficult stream to cross, on account of rocks and rapid water. People have been drowned in attempting the crossing.

The Tazlena, the next stream of importance, is easy to ford except in time of high water. From this stream into Copper Center, a distance of 12 miles, there is an especially favorable section from an agricultural standpoint. The land stretches back from the river in level benches, and the soil is a dark rich-looking loam. A good portion of the tract has been burned over the past season and could be cleared easily. There are some large trees, but the timber is mostly small. It is impossible to say how much good land there is in the Copper River Valley. From my hurried trip I have no definite knowledge of the land except that along the trail, but from what I saw, and from the opinions of others that I met and talked to, there is certainly a very large area in the Copper River Valley that is all one could wish for in soil and exposure from the standpoint of the agriculturist. People throughout this section quite generally believe that there is an agricultural future for the Copper River Valley.

At Chestochena station agriculture in Alaska was being discussed, when two old miners who formerly worked in the upper Sacramento district in California entered the cabin. One of them immediately expressed the opinion that the first man who came into the country to farm should be hanged. He blamed the farmers of the Sacramento Valley for the closing of the hydraulic mines on the upper part of that river, and he seemed to imagine that farming in Alaska would be detrimental to the mining interests of the Territory. The same man spoke highly of the upper valley of the Gakona River as a farming country.

About half a mile northwest of Copper Center, near the Government trail, is the southeast corner of a tract of land a mile square that I staked and reserved for an agricultural experiment station by posting a notice on this corner stake.

At Copper Center Mr. Davis, the proprietor of the hotel, showed me some grain that had been grown in the garden of a Mr. Holeman, who formerly was in the hotel business here, and who has settled on 80 acres of land upon which the town is now built. Of this grain oats made a fine showing, there being 3 feet 9 inches of straw, with well filled heads of fully matured grain. Rye stood 6 feet 2 inches high, but the grain though fully formed had been damaged somewhat by the recent frosts. The wheat showed a fine stand of tall strong straw, the grain being in much the same condition as that of the rye. These grains were sown between the first and the middle of June, and would all have made excellent feed. I am told that seeding may begin here early in May, in which case spring rye and wheat will mature, and certainly fall wheat and rye, as well as barley and oats, will mature perfectly. I also saw some grains that were sown rather late in June by one of Captain Abercrombie's men from seed furnished by the Sitka Experiment Station. They were similar to those grown in the garden of Mr. Holeman as regards maturity.

I spent the 23d day of September looking over the surroundings of Copper Center, and I am satisfied that in many respects it is one of the best locations for an experiment station that I have seen. The soil is fertile, can be cleared and worked easily, most of the ground having recently been burned over, and, if I have been informed correctly, there are no frosts in the summer months, and the land is typical of large areas in the Copper River Valley. A station here might be beneficial to the natives of this section; they are not a progressive race and they are the least resourceful of the Indians in Alaska that I have seen. From a physical standpoint they are not the equals of the Indians on the coast or the Yukon Indians; nor are they anything like as progressive. Many of them still live in shelters covered with bark, and their methods of fishing are decidedly crude. The apparatus for taking the fish is a willow basket fastened to a spruce pole. The fisherman walks out on a rude platform, which extends over the stream, and he uses his basket as a dip net. Fish is the principal food of these people, and when the salmon run is light, the indifferent catch that may be made with the basket nets is not sufficient to keep hunger from the camp during the winter. Large game is becoming scarce, and each day the Indians' chances for making a living become less. They seem willing to help themselves if shown how, and it may be that they will plant gardens if they could see that a benefit was to be derived from so doing. If something is not done for them, the Indians of the Copper River will soon have passed away.

There are difficulties in the way of establishing an agricultural

experiment station at Copper Center. The settlement is 103 miles from Valdez, and supplies would have to be taken in overland from the coast in the early spring when prospectors are going into the diggings. The trail would then be good most of the way; but on the summit and on the Valdez side storms are apt to occur at any time, and they sometimes block travel for days. Farm implements would of necessity have to be hauled to the station before the snow goes off. Provisions, of course, can be packed in at any time; but this is expensive. During the past summer season 50 cents a pound was paid for packing goods from Valdez to Copper Center.

Early on the morning of the 24th we again started toward Valdez, 103 miles distant as the Government trail runs. We crossed the Klutena River near Copper Center, over a bridge built by the trail-makers. This bridge is similar in construction to other bridges which span the streams between here and Valdez. Cribs are put in place lengthwise of the stream, one in the center and one on each side of the stream. Bed pieces are placed on these cribs and the bridge is well braced above. The floor is made of poles about 4 inches in diameter. After crossing the Klutena bridge, we turned to the left and followed the bank of the Copper for several miles. A new trail was being opened when we passed along. It joins the original trail above Tonsena Lake, and is built to avoid the swampy land between Copper Center and this lake. Leaving the Copper River bank, we passed over some 5 or 6 miles of heavily timbered country; the moss was not deep here and the soil was well drained and rich-looking, dark in color, with just enough sand to work up easily. The size of the trees would make clearing costly as compared with the amount of labor it would require to clear the land near Copper Center. Grass was growing in scattered bunches through the woods, but there were no patches of any size. About noon we passed close to a lake where the trail men were working, and we had to make our way through the woods to the old trail as best we could, and the task was none too easy. The timber was dense, and chopping was necessary in places in order to get the pack animals through. The day was cloudy, which made it difficult to keep the direction, and the situation was made more confusing by trees that were blazed in a seemingly promiscuous manner, which made it difficult to follow a course in any direction. By this time it had begun to rain, and all together it looked as though we would not reach Tonsena road house by night, as we had hoped to do; but about 4 o'clock a blazed trail that it was possible to follow was discovered, and we were shortly afterwards on the Government trail again, about 6 miles from Tonsena road house. It was dark and raining heavily when we reached Tonsena. This was the only rain we had during the trip. There is a Government bridge across the river at this place.

From Tonsena the trail leads through Kimballs Pass. For several

miles from the river the trail rises gradually over a slightly rolling country having a rather light, poor-looking, and somewhat stony soil. Early in the forenoon we reached a point where snow had fallen the night before, and we had a depth of 2 inches in the pass proper. The grade on each side of the pass is gradual and the elevation is probably not more than a thousand feet above the trail.

After leaving Kimballs Pass the trail is muddy, there being a black muck or boggy soil across the Ernestine Divide, which is really a large, elevated, almost level, and mossy section, from which flow the South Fork of the Tonsena on one side and the Ernestine Creek on the other. We stopped at "The Barns" on the evening of the 25th. At this point the Government has a large barn to shelter horses which it may be desirable to keep at this place during the winter months. A member of the signal corps is in charge of the station. The telegraph line is in operation between Valdez and Copper Center and men are stationed about 25 miles apart along the line. After leaving "The Barns" our course is along the North Fork of the Tiekell River. In places this stream has a valley 2 or 3 miles wide; in other places it is closely shut in by mountains on either side. There are evidences of snow slides at various places along the trail, chiefly in the form of great bowlders that have come down with the snow during the winter season. Soon after crossing the bridge over Stewart Creek we passed up and over a considerable elevation, where the trail was steep, muddy, and somewhat stony. We were now following a mountain pass up the Chena River. Timber here was rather sparse and the trees somewhat stunted in growth. The Chena is bridged at a point where it flows in a narrow bed between perpendicular rocky banks. About a mile and a half from the bridge is station "Number Three," put up by the trail builders, and which consists of two Government buildings. One is used for a storehouse for supplies, the other is a dwelling for the signal-corps man who is stationed here. We remained at this station over night. Next morning our horses were missing, but they were finally found some 4 miles up the trail, near an old mail station, where grazing was good. At this place I saw timothy grass that stood 3 feet high. The seed had evidently been scattered from hay that had been fed to the mail horses. The elevation here is about 3,000 feet, and glaciers may be seen in a number of different directions. I counted 6, none of them distant. We had intended to make it into Valdez on the 27th, but the action of our horses delayed our start. The grade to the summit is a gradual one and the climb is not at all difficult. Near the head of Ptarmigan Creek, well up toward the summit, the land stretches with a gentle upgrade in all directions from the creek bed, and here the ground is grass-covered, the land is somewhat marshy, and the vegetation is like swamp grass in appearance. We had a fine day for crossing the summit, and the scenery, as the trail led over low

elevations, each of which we had considered would take us to the summit of the pass, was most interesting.

There is so much sameness here and such a lack of definite landmarks that it is difficult to follow the trail after snow has fallen. One is much impressed with the danger and difficulty that a traveler would encounter in crossing the summit during a storm. The summit is some 2 miles wide and is about 25 miles from Valdez. The trail down into Dutch Valley, which is a sort of basin to which the mountain sides slope in the direction of Keystone Canon, takes a somewhat winding course, but the grade is gradual. A portion of the trail had caved off, in one place leaving a narrow ledge close to the bank from the side of which the trail had been cut. There was room on this ledge for a horse without a pack, but an animal with a large pack would likely be crowded over the bank, which was about 15 feet high. Two horses with large loads had been crowded over the bank the day before we passed. Our horses had very small packs now, and it was considered safe to take them across without unpacking. This opinion proved to be correct. A little farther on a glacial stream had to be forded. This stream was not deep, but the bed was lined with bowlders, over and around which the water rushed rapidly. Formerly there was a bridge here, but high water had carried it away. There is some very fair timber in this part of the valley, a scattering growth of grass, and the undergrowth that is common along the southeast coast of Alaska. A few small garden spots may be found here, but there is no extent of farming land. The soil is a disintegrated granite and in most places is stony.

We had intended to stop for the night at Workman's road house, some 18 miles from Valdez. On reaching this place, however, we learned that the *Bertha* was due to sail from Valdez the next day. The moon was at the full, and as there was a prospect that our good weather would not last much longer we concluded to travel by moonlight. After allowing the horses to rest for several hours we started, about 9 o'clock, on the last stage of our journey to Valdez. The moon shone dimly through a thin layer of cloud, giving sufficient light to enable one to follow the trail without difficulty.

The scenery in the canyon was impressive. There was no wind stirring, and the moonlight striking through the clouds gave a sort of weird appearance to objects along the trail, which winds back and forth along the wall of the canyon, now approaching the river and again going from it. The night was filled with the sound of rushing waters, and the mountain streams, which in places fall almost perpendicularly for several hundred feet, appeared like long bands of white upon the mountain side. The effect is greatest at points on the trail where one can look from some narrow ledge almost straight down on the river far below.

The trail through the canyon was the most difficult task the trail builders had to encounter, but here as elsewhere the work was well done. The Government trail from Valdez is a great help to one going into the interior. Good work has been done as far as the Tanana River, 265 miles from Valdez, and while the trail is far from being a good wagon road in the summer months, it will afford a splendid sled road, and even wagons could be used before the frost leaves the ground in the spring. To one who knows anything of trail building in Alaska the surprise is not that the trail is no better, but rather that it is as good as it is. After leaving the canyon we traveled down the bed of the Lowe River, which spreads over a large gravel flat. In places the trail led through timber for a short distance, and here the large trees, clear of branches for 50 feet, and the large rank ferns which grow in great masses, cause one to forget for a moment that these are Alaskan products.

We reached Valdez on the morning of the 28th, and I sailed on the *Bertha* about noon the 1st day of October.

Isaac Jones,
Assistant, Alaska Investigations.

Prof. C. C. Georgeson,
Special Agent in Charge of Alaska Investigations.

NOTES AND COMMENTS ON REPORT OF MR. JONES.

This report by Mr. Jones is the first attempt that has ever been made to describe the agricultural features of the region which it covers. He gives a succinct and systematic account of those features in the territory he passed through which would naturally be noticed by an agriculturist. The character of the surface, the kind of soil, its slopes and exposure to the sun, the vegetation, the water courses, the drainage of desirable tracts, distances, and the character of the trail. He points out the unfavorable features as well as the favorable ones. The sharp, uncompromising mountain ridges which cover large areas; the steep and rocky hillsides, and the wastes of bog and marsh land are noticed as well as the great meadows and the expansive valleys of fertile alluvium. He notes also the few natives which inhabit this region, their condition and their prospects. It is to be observed that this reconnoissance covers only the region which can be seen from the trail. Broadly speaking this is a strip about 30 miles wide by 435 miles long, the distance between the two terminals. Outside of this strip we know as yet little or nothing as regards the areas available for farming and grazing; but it may not be unfair to assume that the region south of the Yukon will average about as the strip here described. If we follow the sixty-third parallel from east to west, which nearly bisects this vast region, we shall find that the distance in a straight line from

the Canadian boundary to Bering Sea is more than 600 miles. It therefore contains twenty times the area covered by this description, and presumably the same ratio also holds good for land which may have value for farming and pasturage.

There are in this region besides the Copper and Tanana rivers the Sushitna and Kuskokwim, both of which are known to have extensive valleys. Captain Glenn, of the United States Army, explored the Sushitna in 1899, and he reported that the valley was 50 miles wide, and that some of its tributaries had also very broad valleys.

The Kuskokwim we know comparatively little about beyond the general facts that it drains a region even larger than that drained by the Copper and that its valley is in places very broad. These facts, taken together, scarcely admit of a doubt but that there are many very extensive areas of land which may have value for the farmer and grazier in the region south of the Yukon. Nor is it to be doubted that the best land from an agricultural standpoint, and the best climatic conditions which the interior affords, are to be found here.

The leading characteristics of the strip covered by Mr. Jones's report may be conveniently grouped under three heads, corresponding to the three natural divisions outlined by the drainage systems; namely, the Fortymile country, the Tanana Valley, and the Copper River region. And as each has some features which are in a measure peculiar to itself, it may be well to review them briefly.

THE FORTYMILE COUNTRY.

The Fortymile River is a considerable stream which empties into the Yukon some 50 miles below Dawson, and almost equally distant from Eagle, the first town in American territory. At its mouth is a small settlement called "Fortymile." From this point trails lead up toward its source, and to many of its tributaries, which are among the first gold-bearing creeks discovered in Alaska. Only a short distance of the lower portion is in British territory. Its entire drainage system lies in Alaska. Its general course is in a northeasterly direction, though the north and south forks, its two leading tributaries, run almost directly east, and the latter even runs southeast in a portion of its course.

The Fortymile makes but an inconspicuous stream on the map, but it nevertheless drains a large area, many small creeks radiating from it, not unlike the venation of some leaves. For a distance of about 25 miles from Eagle these small tributaries cut up the country into a series of narrow ridges, which can have but little value for agriculture. Their sides are for the most part too steep and rocky to admit of anything more than garden patches for cultivation, and they are also quite generally rocky and barren, so as to produce but little pasturage.

Having passed this region we come to the first considerable tract which may be of value for the farmer.

This is an extensive gentle slope facing toward the southwest, and which Mr. Jones estimates contains not less than 30 square miles. That amount of good land is in sight, but how much more there is must for the present remain a matter of conjecture. As far as examined the soil was found to be a sandy loam; that is, what is usually classed as a "warm" soil, and the kind one would require for the rapid growth of crops; and much of it is covered with a heavy growth of native grass, which is in itself proof that the ground is productive. Nor is timber wanted to supply the needs of the settler.

Liberty Creek, which drains this slope, runs in a southeasterly direction, and flows into O'Brien Creek, which in turn empties into the Fortymile. It carries considerable water. When Mr. Jones passed the stream was about 30 feet wide, and would average a foot in depth, and the creeks were not swollen at the time.

About 10 miles farther on the base of "The Dome" is reached, the trail passing to its left. From this landmark for a distance of 23 miles, until the trail crosses the Fortymile at the mouth of Steele Creek, is a region of rolling country, with low, round-topped hills. The whole region would afford much pasturage. Grass was found everywhere interspersed with wooded slopes, and here and there tracts from which farms could be carved. Here, then, is a tract approximating 700 square miles, or, in round numbers, 450,000 acres, which would have considerable value as a range for live stock during the summer months. How much larger the area may be can not be stated at present, as we can speak with certainty only of that portion which was in sight, and which averages about 15 miles on each side of the trail.

Steele Creek enters the Fortymile from the south at this place. The latter stream, running due east and west, is for a portion, at least, the boundary of the range country just described.

For the next 22 miles, from the mouth of Steele Creek to Franklin Gulch, the country is more rugged and broken, and has for the most part very little value for either the farmer or the grazier.

It was at the mouth of Steele Creek that Mr. Jones saw, on the 12th of September, what he describes as a small patch of very good oats. It stood 3 feet 6 inches high, and had good heads of fully matured grain. This little patch of ripe oats speaks volumes for the possibilities of the country. The seed was sown in June, he was informed, and it had therefore grown to full maturity in a hundred days or less. These oats were doubtless such as are brought into the country chiefly from California and Oregon for horse feed. The chances are, therefore, that it was not an early variety, but such as is commonly grown in California. If common oats will mature there, it is certain that

barley will also do so. And it is almost certain that spring wheat and spring rye can be grown there with equal success. In other words, these oats practically proclaim that it is possible to grow all the common hardy grains in that region, at least in the valleys and on the southerly slopes of the hills. The Fortymile at the mouth of Steele Creek is a respectable stream, even when not swollen by freshets. It is about 260 feet wide, and very swift.

From this point to Franklin Gulch, a distance of 22 miles, as already noted, and for 10 miles the other side of Franklin Gulch, the trail runs through a rugged and almost worthless region from the standpoint of the farmer. Franklin Gulch has no valley land, but about 10 miles from the creek to the southward the northern boundary of an extensive region which may prove to be some of the best country in the interior is reached. This tract comprises the "Ketchumstock Flats," which Mr. Jones describes quite fully. He estimates that there are 750,000 acres, half of which could be brought under culture with ease. In reality the area of good range country is much greater.

Beginning about 10 miles south of Franklin Gulch, or about 90 miles from Eagle, the trail runs through this rolling, grassy country for 60 miles, or to within 20 miles of the Tanana River. It is in large measure a rolling country with gradual slopes. Much of it is wet, owing to an impervious subsoil; but it is a good grazing country, and "the timber is of good size and of dense growth." In the center of this area is a grass-covered level plain about 8 miles across and increasing in width upstream. A portion of it is what the prospector calls "nigger-head land." These nigger-heads are bunches of sedges which grow in wet places, usually where seepage water from higher ground comes to the surface. The bunches or heads usually stand from a foot to a yard or more apart, and in the course of years each becomes a compact mass of roots which gradually rises from the surface to the height of a foot or more, and it may measure as much in diameter. When the dry tops are burned off it leaves the scorched and blackened heads, which may have suggested the name.

Nigger-head land is of no value for cultivation, or even for pasture, until thoroughly drained, and drainage would be too costly an operation for settlers to undertake until the country is peopled to such an extent as to cause a rise in land values. However, these nigger-head lands do not occupy any considerable portion of this vast tract. Good pasture can be found over nearly the whole area, and the Ketchumstock Flats, the boundaries of which are not fully known, can be brought under culture with as much ease as the prairie land in the west. It is in this grass country that horses have wintered successfully several times. Mr. Jones mentions two instances which are well authenticated. In one case two horses had gone through two winters and still roamed about there in a semiwild condition. Another instance was told me by a miner, Mr. Mark E. Bray, whom I met on

the Yukon. He makes his headquarters at Dawson while his mining interests are on the Tanana, and he packs his supplies out from Dawson. He informed me that in the fall of 1899 he left five mules at the head of the Chusana River, which is perhaps 75 miles to the southeast of the Ketchumstock Flats. In April the following year he found four of them sound and fat; the fifth had been killed by the Indians.

I have recorded similar instances in former reports. These facts prove that the winters are not so severe but that horses and mules can live through them in the open, and that there are large stretches on which they find enough feed to sustain life in spite of the snowfall.

The snowfall in Ketchumstock Flats and Tanana Valley is reported to be considerably lighter than on the Yukon, where it averages from 2 to 3 feet. It might be reasonably expected that the snowfall in the interior would be light, inasmuch as the region is far from the sea, and to the south and west it is bounded by high mountains along the coast, which would cause a precipitation of the moisture in the air before it is carried inland. The creeks traversed by the trail through this section are successively Ketchumstock Creek, Indian Creek, Mosquito Fork, and Wolf Creek.

Ketchumstock Creek was at the time Mr. Jones passed about 60 feet wide and 3 feet deep. It runs through the Indian village from which the region takes its name. About 10 miles farther on, Indian Creek is reached, which is only a very small stream, about 6 feet wide. It may be of importance as a source of water for stock raising. About 12 miles farther on the trail crosses Mosquito Fork, which is the name given to the upper portion of the South Fork of the Fortymile. It was so named because of the myriads of mosquitoes which infest the region. At this point the creek has an easterly course, and Mr. Jones found it to be about 150 feet wide and 4 feet deep. It has its source in the divide which separates the Fortymile country from Tanana Valley, and is fed by numerous small creeks.

Wolf Creek is a very small stream, the last crossed by the trail before the divide which separates the Fortymile system from the Tanana Valley is reached.

So far as known, cattle, which the Indians call "McKinley moose," have as yet not been introduced into this region. Some cattle have, however, been driven into the Copper River Valley. And in this connection it may be mentioned that some enterprising person drove four dairy cows into the mining section of the Chestochena the past season, and later they were driven back to Valdez. What success attended the enterprise was not learned.

THE TANANA VALLEY.

The Tanana Valley is separated from the Fortymile country by a divide, which on the north side rises in successive elevations of low, round-topped mountains covered with vegetation. It is not a stony,

rocky ridge; there is scarcely an elevation which could be called a peak in sight along the divide, and yet it is too rough to have any agricultural value, except as a range for sheep and goats. On the south side the valley is likewise bounded by a divide, which separates it from the region drained by the Copper River system. This divide is decidedly more rugged than the one on the north side, but still it has no high mountains with glaciers or snowy peaks. In the middle of September, when Mr. Jones passed through, some of the highest elevations had just been capped with fresh snow, but during the summer there are no snowy mountains within the region under consideration. The distance from the top of the ridge on one side of the valley to the top of the ridge on the other is about 50 miles. Between the two lies the Tanana Valley proper.

The river takes its rise in the same elevated portion of the coast range from which the White River and the Copper River also spring. The White River runs almost due east, and soon enters Canadian territory. The tributary of the Copper which rises here runs west until it joins the main river; and the general direction of the Tanana is northwest.

The Tanana is a large river, which measures in a straight line from source to mouth more than 400 miles, and counting the windings it may be twice this length. It is of varying width, but generally spreads out from half a mile to 2 miles in width. In the lower half of its course there are numerous islands. At the point where the trail crosses the stream is about 500 feet wide and moderately swift. The water carries much sediment and is of a milky color at this point, indicating that some of its upper tributaries take their rise in a light-colored clay soil. The valley proper, from base to base of the two divides which hedge it in, is about 25 miles wide. It is almost a level tract, with but a slight and very gradual rise from the stream toward the divide. The banks are about 15 feet high above the stream at normal level of river. So far as known the river does not overflow these banks at any time, but we have no definite knowledge on this point. Where the trail crosses the river is in about the middle of the valley.

The valley in the belt under consideration is for the most part covered with a sparse and scattering growth of spruce, with some poplars. The forest can scarcely be said to be continuous, as there are many small patches of open meadow. Near the river, and especially in low places in the bends of the stream, the growth was the densest and the timber the largest; spruce trees 18 and 20 inches in diameter were plentiful. On the dry land away from the river the timber was smaller, and the growth open and scattering. There was very little continuous grass land in sight, but scattering bunches of grass everywhere. A low straggling blueberry bush was abundant, where not crowded out by the spruce, and a very light coat of moss covered the ground. The

soil is a dark, sandy loam, and in the valley proper there was no niggerhead or marsh land too wet for cultivation. It will probably be found that the greatest drawback to cultivation is a lack of rain during the growing season, although on this point we have no definite information. As soon as settlers come in, who will undertake the work, meteorological stations should be established, not only here but in the Fortymile farming region, and in the Copper River region. How broad the valley is above and below the belt under consideration we do not know, but to judge from the mountains in sight it is as broad or broader than at this point.

Mr. Jones makes the important observation that this valley appears to be milder than the Yukon Valley. He saw no evidence of killing frost there in passing over the valley on the 17th and 18th of September, while in the Yukon Valley there had been several killing frosts before that date. This evidence is confirmed by other observers.

Mr. J. L. Green of Rampart, in a letter submitted with this report (p. 309), makes the same observation. He states in effect that the spring begins earlier, and the autumn frosts set in later in the Tanana Valley than on the Yukon. And Mr. Erastus Brainerd states in an article published in the Seattle Post-Intelligencer of September 29, 1901, that in the spring of 1900 the ice broke on the Tanana in the second week of April, while it did not break on the Yukon until the third week in May, and also that during the latter half of May he found ice and snow in the Yukon Valley, whereas in crossing the divide into the Tanana Valley he found the redtop grass as high as his shoulder, and lupines and vetches in bloom.

Briefly stated, all evidence so far brought forward is to the effect that the Tanana Valley has a considerably longer growing season than the Yukon Valley. And the chances for success in farming are correspondingly greater. So far as the writer has been able to learn, no attempts at gardening or grain growing have as yet been made by anybody in the Tanana Valley. There is a very promising and extensive area of agricultural land there, but the possibilities of soil and climate have not been tested.

THE COPPER RIVER REGION.

As already noted, the divide which separates the Tanana Valley from the Copper River country is quite high and in places rugged. The trail runs through a low rolling cut in the mountains, known as "Mantasta Pass." The region drained by the Copper River differs from the Fortymile and Tanana Valleys in that it is more broken and more extensive.

On the south it is bounded by the coast range, on the east and north by the watershed which separates it from the Tanana, and on the west by a divide which separates it from the Sushitna. The river rises in

the coast range and flows first northwest, then west, and finally south, in the shape of a great sickle. It has numerous tributaries from both sides, and some of these flow through more or less extensive valleys of what appears to be good agricultural land. However, that portion of the Copper River country embraced in Mr. Jones's report lies almost wholly to the west of the main stream. The region to the east of the main stream we know but little about, except the general report of prospectors that there are extensive tracts of level or rolling land.

For a distance of some 12 or 14 miles from Mantasta Pass the trail leads down the divide, then a stretch of low rolling country is reached. This stretch of between 30 and 35 miles may some day perhaps be settled by farmers; at present it appears to be too marshy. It is covered with a deep coat of moss, and small lakes, meandering streams, and nigger-head bogs are numerous. This stretch of country ends at the Chestochena River. From that stream to the Tazlena there is a gradual and marked improvement in the country. The ground is less marshy, the moss not so deep, patches of grass are more extensive, and the timber along the stream is larger. Between the Chestochena and Tazlena is a stretch of about 45 miles which in general may be described as a timbered country, with patches of grass land ranging in size from a few acres to a hundred acres in extent. The cost of clearing the timber off the ground would perhaps be the greatest bar to settlement outside the patches of grass.

Nearly midway between the Chestochena and Tazlena rivers a stream called the Gakona comes in from the west. In the upper portion of this river, prospectors informed Mr. Jones that there were large stretches which had a luxuriant growth of grass, and I have since had this statement confirmed by another prospector who had passed through a portion of it. He said he walked over a stretch of level ground with a heavy growth of grass at least 5 miles in width; how long it was he did not know. This grass land is about 100 miles west of the belt we are here discussing.

From Tazlena to Copper Center there is a stretch of 12 miles of most excellent agricultural land. The land lies in benches, one slightly above the other, which will average from half a mile to a mile in width. The soil is a dark sandy loam with a subsoil containing more of clay than on the surface.

There is no swamp land in this stretch or anything in the nature of waste land. It is partly timbered with spruce, but the growth is young and not dense. Fires have been through the whole region, which have cleared the ground of moss and killed the young trees. The land can therefore easily be cleared. The same kind of land, in all respects, continues southward for another 12 miles, the difference being that the timber is larger, denser, and is all alive. It will

therefore be too costly to clear a farm in this region for a long time to come.

The Tazlena River may really be considered as the center of the best agricultural region in the Copper River Valley and within the boundaries of the strip we are discussing, although the best portion of that region lies between the Tazlena and Copper Center, as noted.

From a point 12 miles south of Copper Center to the Tonsena River, a distance of 13 miles, is a rather wet rolling country more or less densely wooded, with small marshes in places, with a heavy coat of moss on the surface and only scattering bunches of grass. It has some value for pasturage, but can not be considered first-class in this respect.

From Tonsena River to Valdez there is practically no agricultural land and comparatively little pasture land. The trail here crosses the coast range; the best portion is the north slope of the range from Tonsena River to Kimballs Pass, a distance of about 9 miles. Here goats and sheep may find pasture. It is not likely even to become a good range country. The soil is light yellow, gravelly in nature, and abundantly covered with stones as large as one's fist.

From Kimballs Pass to Valdez the country is simply a succession of ups and downs, interspersed with rugged peaks and many glaciers, deep canyons, waterfalls, and mountain torrents. In short, it is typical of the scenery that may be found anywhere along the Alaskan coast range, and which from the sea looks so strangely grand and at the same time impresses one as a forbidding waste.

The leading streams which enter the Copper River from the west, and which were therefore crossed by the trail, are the following, in order from north to south: The Chestochena, the Gakona, the Tazlena, the Klutena, and the Tonsena.

The Chestochena is a considerable stream. At high water near the mouth it is about a mile wide, but, except when swollen, the water does not cover the bed, but runs through in a score of different channels. From this river to the Gakona is a distance of about 25 miles. The Gakona is about 250 feet wide; the bed is filled with large bowlders and the water rushes over them in torrents, which makes it a difficult river to ford, and at high water it is dangerous, if not impossible, to cross it. As a matter of fact this can be said of all the streams. From the Gakona to the Tazlena is about 20 miles. This is a small stream in comparison with the two foregoing. It is only about 60 feet wide, nor is it deep, and it can be easily forded at low water. From the Tazlena to the Klutena at Copper Center is a distance of 12 miles. The Klutena is like the Tazlena in size and in the volume of water it usually carries. It has been bridged by the Copper River Exploring Expedition under command of Capt. W. R. Abercrombie, who for three years past has been employed in exploring the Copper

River Valley and in constructing a trail. North of the Klutena none of the streams has so far been bridged. From the Klutena to the Tonsena is a distance of about 25 miles. The Tonsena is a little broader than the Klutena and carries perhaps a somewhat greater volume of water. The mountain streams in the coast range have all been bridged. The Government trail has been cleared to the Tanana River.

The Government telegraph line, which is also under construction, has been completed across the coast range to Copper Center, and is in operation.

Copper Center is a collection of about a dozen log cabins, situated in a small clearing on the north side of the Klutena River. It had its origin in the influx of prospectors which came into the Copper River Valley in search of wealth, in 1898, though at that time the settlement consisted almost entirely of tents. There was at one time several hundred people here, and during the winter of 1898 and 1899 most of those who wintered in this camp suffered greatly from scurvy and many died of this dread disease. At present most of the cabins are empty. Some few prospectors make their homes here temporarily. The Copper River Exploring Expedition has a storehouse and a few men stationed here, and there is also a road house, or so-called hotel, in the place, kept by two men.

Aside from Copper Center and the mail stations described by Mr. Jones, there are no other settlements in the Copper River Valley. During the summer season there are from 150 to 200 men in the placer camps of the Chestochena and its tributaries; and a score or more men are likewise at work during the summer on the very rich copper deposits which have been found in this region, but as yet there are no permanent settlers. That the country can produce grain is proven by the fact that Mr. Jones saw ripe oats in a garden at Copper Center.

In the judgment of the writer, the Copper River Valley has a great future. It will one day be a rich and flourishing country, and perhaps the most populous region of the future State of Alaska. Here are opportunities for thousands of families to make homes for themselves and gain independence. But before settlers can be attracted to this or any other region in Alaska the Government will have to survey the country and make the homestead law so liberal that it will be possible for poor men to take up land.

Before closing this subject a word should be said about Valdez, which is the southern terminus of the trail. If the country in the interior is opened to settlement, Valdez is almost certainly bound to become a large and important town. It lies at the head of a bay which is open the year round, and naturally it must become the port for all the traffic going in and out of the interior. Valdez is even now a vigorous and enterprising young town. There are many good houses

in the place, and the people have begun to build large and ornate churches. The town has good hotels, good restaurants, good stores for all kinds of merchandise, and is settling up with an enterprising class of people. It is not a costly place to live for the accommodation afforded. The traveler can perhaps live cheaper here than in any other place in Alaska. The writer has eaten an excellent meal at a public restaurant for 35 cents. The town is built on a gravel flat which extends back for 4 miles and there terminates in the Valdez Glacier. I present a view of the town herewith (Pl. XIX, fig. 1), taken from a boat in the harbor. In this view the glacier seems very near, but, as noted, it is 4 miles distant.

Five miles from Valdez, on the shore of the bay, in a pretty little nook under the mountain, the Government has built an army post, which has been named Fort Liscum. With its stables, warehouses, barracks, and officers' quarters, all laid out in streets, the fort appears almost like a small town in itself. The buildings are unpretentious, but have a substantial appearence, and everything has an air of superlative neatness which is characteristic of all Government posts.

NOTES ON THE COPPER RIVER COUNTRY, BY MAJ. W. R. ABERCROMBIE.

Maj. W. R. Abercrombie (then Capt., Second United States Infantry) has been in charge of the construction of the military road which is now building between Valdez and Eagle. As noted in the foregoing, this road has already been completed as far as the Tanana River, a distance of 265 miles from Valdez. The Major has spent three years in the Copper River country, and is, of course, thoroughly familiar with all its characteristics. He is of the opinion that it affords excellent opportunities for farming. In fact, he has done some quite successful experimenting. He has raised good gardens, both at Valdez and in the interior. The following letter explains the situation briefly:

TRANS-ALASKAN MILITARY ROAD,
Fort Liscum, Alaska, November 20, 1901.

SIR: I sent you by steamer *Newport*, care of Captain Moore, a sample of Finnish black oats grown in the Copper River Valley at Copper Center from the seed sent me by you last spring. The wheat matured, but was trampled down by my beef cattle. All the vegetables grew and matured. The inclosed photograph will give you an idea of the garden, which was on new ground burnt off last May.

Very respectfully,
(Signed) W. R. ABERCROMBIE,
Major, Thirtieth Infantry.

Prof. C. C. GEORGESON,
U. S. Department of Agriculture, Sitka, Alaska.

At my request the Major has kindly sent me the following as an expression of his views on the agricultural possibilities of the region through which he has been operating:

AGRICULTURAL POSSIBILITIES OF THE COPPER RIVER VALLEY AND ITS ATTRACTIVE FEATURES FOR THE SMALL FARMER.

Having watched for the past twenty years the growth of our former Northern frontier, i. e., Dakota, Montana, Idaho, and Washington; having traversed the Yellowstone, Gallatin, Spokane, and other valleys prior to the advent of the rancher and the railroad, I feel qualified in a measure to give an intelligent opinion relative to the capabilities of the soil and the prospects of the small farmer who is constantly on the move in the search of a home in a new country.

I find the conditions as varying in different parts of the Copper River Valley as the great range of climatic conditions would naturally dictate. The disappearance of the snow and the sprouting of the grass varies at least forty-five days in different portions of the valley. Along almost every route that has been traveled by pack animals will be found scattering spears of timothy and grain.

I shall first consider the route traveled by the pioneer horsemen of the season of 1898, as that was the only year in which pack animals were used over the route from Valdez to Copper Center via the Valdez Glacier and Klutena River. During the past season spears of timothy and grain were found along this trail, which would indicate that the original seeding of 1898 reseeded itself, with the result of a volunteer crop in 1900, which to my mind is conclusive evidence that, when acclimated, grain and hay will both mature and bring forth abundant crops. From the evidence obtained in a small experimental garden it is an assured fact that potatoes, turnips, beets, peas, lettuce, radishes, and possibly many other vegetables will grow in abundance when the proper soil, exposure, and drainage are obtained. As the existence of the small farmer is conditional on the laws of supply and demand, it will be necessary, too, in this instance, having found the supply, to point out the probable demand. Two hundred and fifty miles inland from Port Valdez, in a northerly direction, lie the gold fields of the Chesna mining district, which, in my opinion, in the next few years will produce many millions of dollars of gold dust.

There is to-day, aside from the 200 or 300 head of horses, the property of the Government and individual owners, absolutely no means of transportation between these two points—Valdez and the headwaters of the Chestochena River. A pack animal loaded with forage at Valdez, if no means of subsistence were to be had en route, would consume more than the forage he could pack before reaching his destination, which fact is attested by the scores of dead horses whose carcasses mark the advancement of settlement along the Trans-Alaskan Military Road. Hay and grain to-day at Port Valdez, original cost and marine transportation added, will average $40 per ton. This forage can not be transported into the Copper River Valley to the crossing of the Tonsena for less than 25 cents per pound, and then the margin to the freighter is extremely meager. Therefore the opportunities to-day awaiting the small farmer who will select his homestead judiciously along the Trans-Alaskan Military Road, with a view of erecting thereon a bunk house and barn for the accommodation of man and beast, and the cultivation of forage for the animal and the vegetable produce for the man, is, in my opinion, so much more enticing than the inducements held out for the bleak prairies of Dakota or the wind-swept valleys of the Yellowstone as to be beyond comparison.

Referring to my report of 1899 on this subject, I would say that I am more profoundly of the opinion to-day than ever before that the valleys of the subdrainage of the Copper River Valley will in future years supply the demand for cereals and vegetables, if not meat, of the thousands of miners that will be required to extract the vast deposits of metals from mother earth in the Chettyna, Kutsena, and other districts. Referring to the available arable land for the cultivation of forage, I shall eliminate the coast range entirely, for the reason that, owing to the heavy fall of snow the spring is generally one month later than in the Copper River Valley, the crest of

the mountains being capped, as they are, with monster glaciers, cause daily precipitation from the 1st of July until freezing weather in October. While vegetation and fodder grow luxuriantly in the coast range district, forage must be treated as silage, as, owing to the constant rain, it can not be otherwise cured.

Following the South Fork of the Tonsena will be found thousands of acres of available land for cultivation, which, having been burnt over years ago and divested of its covering of moss, needs only now to be cleared of the dead spruce timber that encumbers it, when it is ready for the plow. Five miles north of the Tonsena bridge are tracts of land well timbered and drained that are likewise available for agricultural purposes. A few miles north of the mouth of the Tazlena is a stretch of sandy, loamy soil with a southern exposure that looks attractive. At the mouth of the Tonsena River is a large hay meadow many hundreds of acres in extent on which quantities of hay could be cured. I desire to point out in this connection that a few experimental stations, with competent persons to test the soil and collect such evidence as would enable the settler to intelligently locate his homestead, could not be established at any point to better advantage by the Government than at one of the points mentioned above. * * * In my opinion the backbone of the settlement of this mighty valley is its agricultural resources.

NOTES ON THE TANANA VALLEY, BY MR. J. L. GREEN.

Having learned that Mr. J. L. Green, an attorney at Rampart, had made a somewhat extended tour through the valley of the Tanana River, I asked him to write me a statement of his views concerning the agricultural features of that region. This he kindly complied with in the following letter:

RAMPART, ALASKA, *April 22, 1901.*

DEAR SIR: Your letter of March 17 received to-day. In reply would state that I will most cheerfully furnish you all the information I can in regard to the agricultural possibilities in the Tanana country; but owing to the fact that I have not been able to experiment any in growing cereals there, my opinion would not be worth as much to you as a statement of the facts regarding that country. However, I will state both, and the opinion you can take for what it is worth.

I had heard a great deal of the country before I made my trip through it, but was pleased to find a better country than I anticipated. The country has a great many large valleys ranging from 5 to 20 miles in width and from 10 to 50 miles in length. The timber is far superior to any I have seen, either in the Yukon or in the Northwest Territory.

I also found very extensive prairies, dotted with lakes. The lakes and swamp lands would perhaps occupy one-half and sometimes probably more than half of the surface of the prairie lands; the higher ground I found dry and of a dark-brown color, and consisting of a sandy loam and very fertile.

This soil was covered with a rank growth of grass (this grass is perhaps the same as the redtop grass or herd grass we have in the States), although the same variety is found in every part of Alaska. I have not been able to find anything in any other part of the country to equal it either in quantity or quality. This grass grows to the height of from 4 to 4½ feet, and will produce from 2 to 3 tons of hay per acre. There are places where a mowing machine can be driven for 5 miles in one direction without lifting the sickle bar.

The surface of the soil thaws from 4 to 10 feet during the summer season. I was in that country during the months of August and September of last year. When I left the last of September there had not been sufficient frost to kill the leaves on the trees, although it would have killed potato vines and all the more tender vegetables.

There was a great deal of rain during September, but no snow. As I neared the Yukon I saw a great change, showing signs of heavy frosts, and when I arrived at Fort Gibbon I learned that they had had considerable frost, and quite a snow storm some two weeks before I arrived, some of which was still visible, especially on the north side of the hills and in sheltered spots. I also learned from the Indians and from white persons who have been in the country in the spring that the season is almost a month earlier than anywhere on the Yukon River.

I am informed that the Chinook winds from the coast, across a low divide in the coast range, clears that country of the snow very early. I know this, that the Tanana River breaks and clears of ice at least two weeks earlier than the Yukon; so evidently the season must be earlier.

As fine a quality of hay can be produced there as can be produced anywhere. I believe spring wheat, oats, and barley will mature there if properly handled. I know that potatoes, cabbage, peas, beans, turnips, carrots, onions, radishes, beets, and a great many other vegetables can be produced there.

Having been reared on a farm in a new country, I have taken quite an interest in and a great deal of pains to learn if agriculture could be successfully carried on in this country; and having traveled over a great deal of the territory, always taking notes of the country I passed over to satisfy myself as to the agricultural possibilities, I must confess that the Tanana country is the only part of Alaska where I believe agriculture could be successful. There can be no doubt about it. The only thing would be to convince the farmer that he must not farm as he does in the States, but must use his head as well as his hands.

To succeed there the soil must be prepared in the fall, and nothing left on the surface to prevent the rays of the sun from striking the soil as soon as the snow disappears. I find from experience that the sandy loam is a better conductor of the heat than the muck, or soil free from sand; that it will thaw from a foot to 18 inches, while the soil composed entirely of vegetable matter will not thaw more than 3 or 4 inches. I find that the nature of the soil and the natural conditions in the Tanana country all combine in a higher degree to favor agriculture than any other part of Alaska.

I sometimes think I would like to turn farmer myself for a year or two to convince the public that even in Alaska farming and grazing can be successfully conducted.

Respectfully,

J. Lindley Green.

Prof. C. C. Georgeson, *Sitka, Alaska.*

FARMING OPERATIONS OF MESSRS. NICOLAI AND CLARK.

Two Wisconsin farmers, Messrs. H. E. Nicolai and D. H. Clark, have formed a copartnership and begun farming operations at Dyea and Skagway. Work was begun in the summer of 1900, when some of the land was cleared, some vegetables were grown for the local markets, and some grain was raised for hay. Both at Skagway and Dyea is a limited amount of level river-bottom land of a quality well suited for farming and gardening. Of these two tracts they have secured 40 acres at Skagway and 120 acres at Dyea. The land is a sandy loam which can be easily worked, and for the present, until it becomes exhausted, it is a rich soil, producing large crops of various kinds, and they have made extensive preparations to increase this acreage next year. They have built a propagating house and hot-

FIG. 1.—ALASKA STATIONS—FARMHOUSE OF MESSRS. NICOLAI AND CLARK, DYEA.

FIG. 2.—ALASKA STATIONS—POTATO FIELD OF MESSRS. NICOLAI AND CLARK, DYEA.

beds in which to raise plants of such crops as are to be transplanted. They have barns, root cellars, dwelling houses, and they have equipped their farms with work animals and implements. Their work has so far necessarily been of an experimental character, inasmuch as they had to feel their way not only in regard to the crops which can be successfully grown there but also as regards the requirements of the market. They have thus tested all the common, hardy vegetables, potatoes, cabbages, cauliflower, root crops of various kinds, carrots, and parsnips, peas, etc., and with scarcely an exception all these crops have been grown with marked success. This year they planted 24 acres to potatoes and set out 35,000 cabbage plants. These two were their leading crops, but they also had several acres of turnips, ruta-bagas, radishes, lettuce, and such crops as are usually handled by grocers. They have, both last year and this year, raised considerable fields of barley, oats, and wheat. These grains, however, have been grown for hay and not for the sake of the grain. Hay is worth $30 a ton, and it consequently pays better to harvest the crops before they mature than to allow the grain to ripen. Oats and barley have, however, ripened on the Dyea farm both last year and this year. I visited their farms at Skagway and Dyea early in September of the present year, and I must say that their crops were gratifying to behold. I have never seen finer cabbages, or vegetables of similar kinds anywhere which could equal theirs in quality. It is by this time an acknowledged fact that vegetables grown in Alaska are far superior in quality to similar vegetables produced in the States. For crispness and richness of flavor Alaska vegetables are unequaled. This is acknowledged by the merchants, and local produce consequently commands a higher price than the same articles shipped up from Puget Sound.

A portion of the ground which they have under cultivation is yet too new to produce the best results. Certain tracts on the Dyea farm are so low as to be flooded by occasional excessively high tides, but on the whole these two gentlemen are much pleased with the results of their efforts, and they have planned extensive improvements in the near future. They are energetic and practical men, who thoroughly understand their business, and now that it has been proved what the soil and climate will produce, there can be no doubt as to their success in the future. Mr. Nicolai has kindly consented to write an account of their operations, which it gives me pleasure to present herewith.

Pl. XX, fig. 1, shows the farmhouse of Nicolai and Clark on their Dyea farm, and Pl. XX, fig. 2, is a view in one of their potato fields at Dyea. Incidentally it shows also the kind of land they are working with. Most of it was covered with timber or stumps, which had to be cleared away. A portion of the present crop of potatoes is grown among the dead timber.

SKAGWAY, ALASKA, *October 1, 1901.*

MY DEAR SIR: According to my promise, I will give a condensed report of our work in the agricultural line here and at Dyea for this season.

Our work commenced about the middle of March in the greenhouse. The first cabbage and cauliflower seed was then sown, and the last was sown about April 1. We commenced transferring the first plants to the hotbeds about April 20.

The first cabbage plants were set in the open field May 12, and the last ones about June 15. The varieties planted were Early Jersey Wakefield, Flat Parisian, Curries Eclipse, and Early Summer. All headed well, and the first two varieties were ready for market about July 20. Some of the last two varieties named were ready for market a month later, and all made good, solid heads by September 20, some of which weighed 15 pounds.

We set out 35,000 plants, and in my experience of twenty-five years as a truck farmer in southeastern Wisconsin I never had a more perfect crop of cabbages. The quality is first class, which can be said of all vegetables raised in this section. The yield was about 15 tons per acre, and the price from 2 cents to 4 cents per pound.

The land on which the above crop was raised is of alluvial formation and was covered with a dense forest of cottonwood and spruce until two years ago. Part of it was broken up a year ago last spring and cropped last year; the balance was broken up last April, and all of it was fertilized with fresh cow manure during the fall and winter. The land which was tilled a year ago produced a heavier crop, and the heads were much more uniform in size.

Our last plants were set on ground on which we had already raised a crop of radishes, lettuce, and set onions. The radish and lettuce seed were sown April 20, and the onion sets were put out about the same time. They were marketed between the 1st and 20th of June. This particular part of the cabbage field spoken of is shown in the foreground on the photograph containing the two ladies and a gentleman in the center of the field (Pl. XXI).

I need not dwell long on our experience in raising rhubarb; the photograph will speak for itself. We sowed the seed a year ago last April, and transplanted the roots last May; the result is shown in Pl. XXII.

Ruta-bagas, turnips, radishes, and lettuce need scarcely be mentioned here, as they grow as luxuriantly here as weeds do in Wisconsin; all that is necessary is to scatter the seed. We sowed turnip seed as late as June 20 and got a good crop, but ruta-baga seed should be sown in the spring to insure a large crop. We had some weighing over 15 pounds.

We have not been able to raise large onions from seed as yet, but have had very good success in raising them for bunching. For this purpose we had them as large as 1½ inches in diameter.

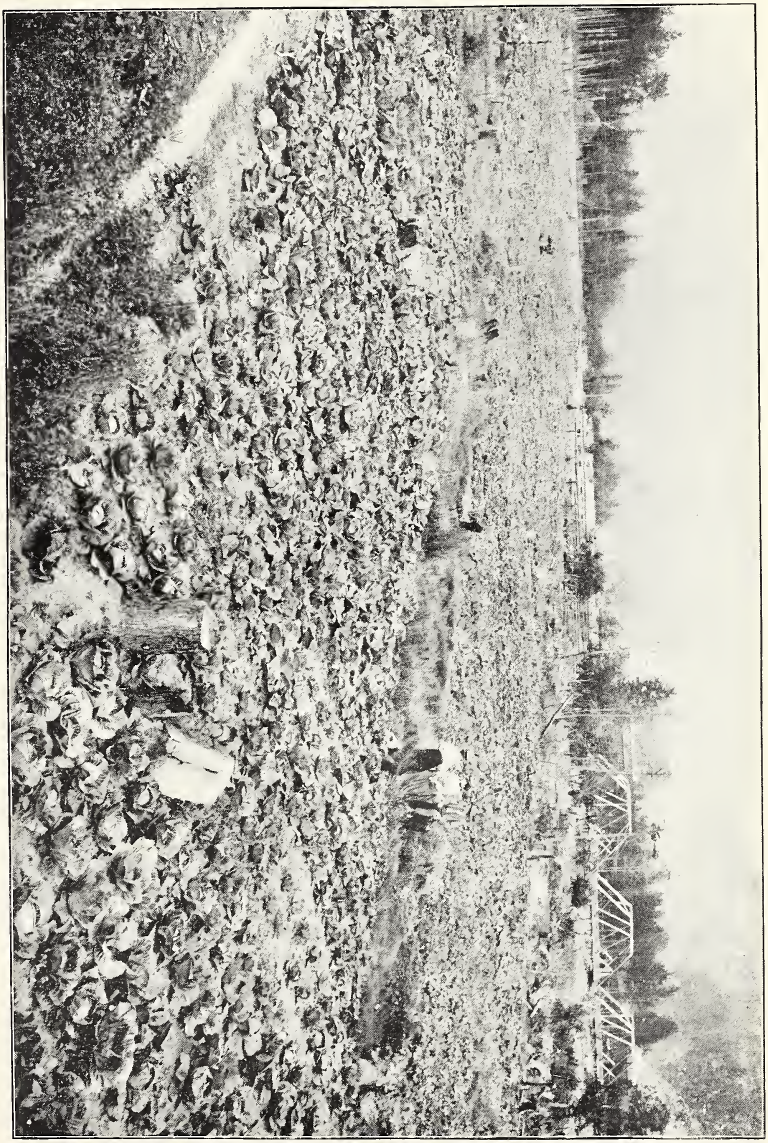
Radishes, lettuce, and green onions can be had fresh from the garden here from June 10 to October 1 by sowing the seed at intervals during the summer.

Our table beets made a fine growth this year. They were ready for bunching for greens June 20, and by the last of July they had attained a size of 3 or 4 inches in diameter—just a good market size.

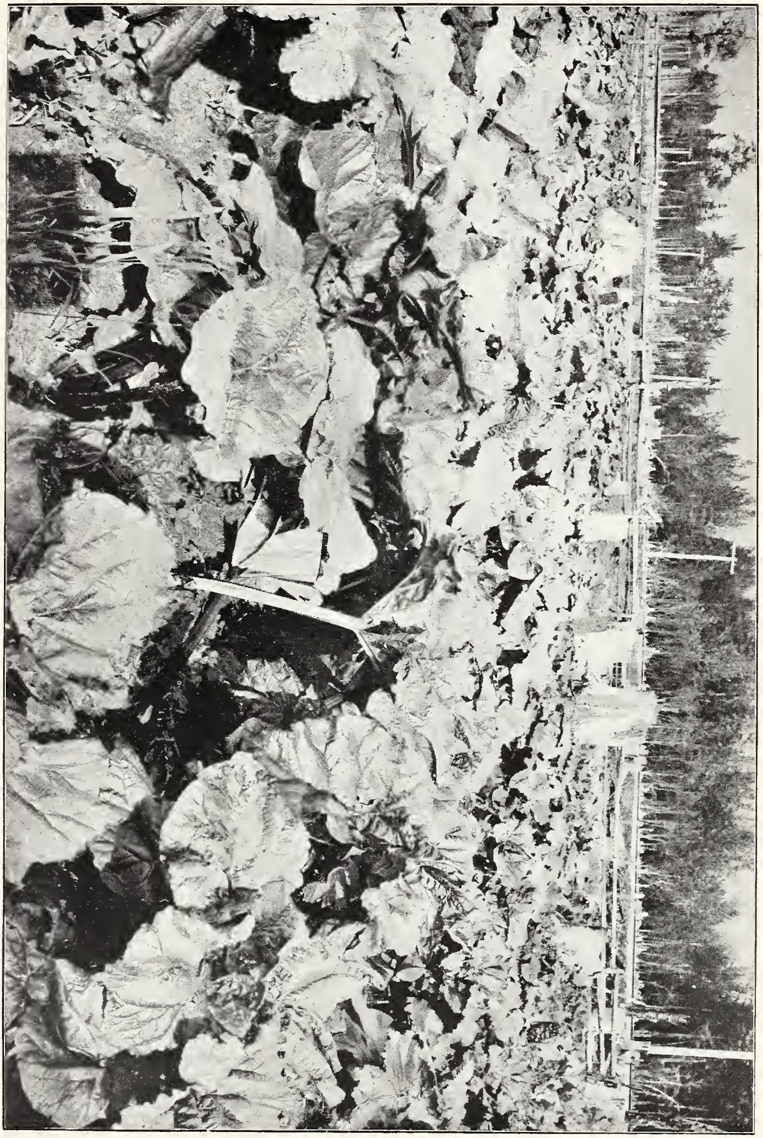
Other vegetables that we have experimented successfully with are carrots, parsnips, salsify, parsley, celery, kale, kohl-rabi, spinach, and cauliflower. The last mentioned is the finest in flavor of any I have grown.

The above finishes the report so far as our work in the vegetable line is concerned, but I feel it would be an injustice to Skagway if I did not mention the wonderful growth and beauty of our flowers.

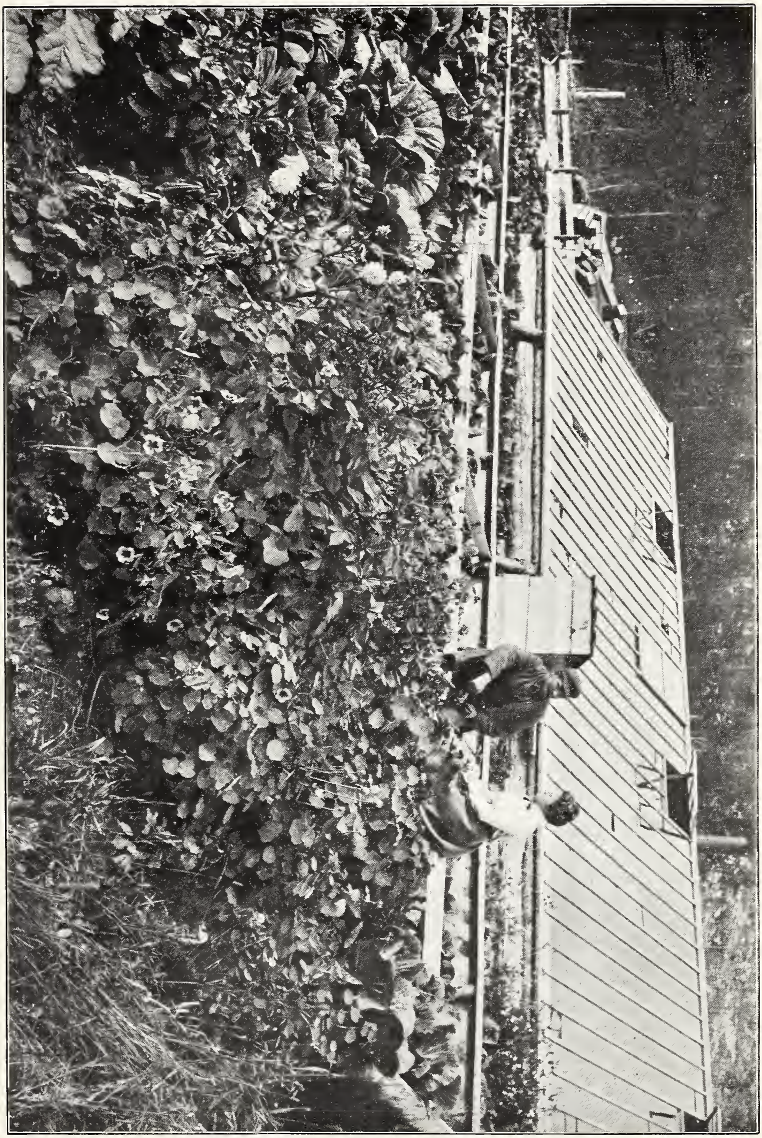
The photograph showing the greenhouse, with Mr. and Mrs. Clark seated on the edge of the hotbed, has a cluster of dahlias and nasturtiums in the foreground, which commenced to bloom about July 10 and are still blooming. The dahlias are exceptionally fine, being very large and perfect in form. The poppies commenced



ALASKA STATIONS—VIEW OF A PORTION OF THE CABBAGE FIELD BELONGING TO MESSRS. NICOLAI AND CLARK, SKAGWAY.



ALASKA STATIONS—A FIELD OF RHUBARB BELONGING TO MESSRS. NICOLAI AND CLARK, SKAGWAY.



ALASKA STATIONS—PROPAGATING HOUSE AND LUXURIANT GROWTH OF FLOWERS, GARDEN OF MESSRS. NICOLAI AND CLARK, SKAGWAY.

to bloom about the same time and have continued in full bloom ever since (Pl. XXIII).

The sweet peas, which are shown in the photograph at the base of the greenhouse and at the right of Mrs. Clark, have been in bloom the greater part of the season and will continue until frost comes.

Mrs. Bigger, at Dyea, had pansies in bloom the first week in May, which had been in the open ground all winter, and are in full bloom yet. Pansies do exceptionally well here, but nearly all ordinary flowers do well, roses included.

EXPERIMENTS AT DYEA.

The land at Dyea is similar to that of Skagway, only a little more sandy and somewhat drier, so that we shall be compelled to irrigate some for certain crops.

I commenced operations at Dyea May 6, with three men and three horses. In explanation I will mention that there had been no preparation made for farming previous to this time, except that there had been a few acres of tide land broken up the year before and sown to grain, which was cut for hay, and about 5 acres in an old slashing where the rotten logs had been picked to pieces and piled. I will also mention that I met with new conditions here in the line of farming, which require new methods of treatment.

On May 10 we planted our first potatoes, 1½ acres of Early Ohio, and on May 15 we planted 4½ acres more of the same variety. May 18 we planted 2 acres of the Early York variety, and another acre of the same variety May 21. These were all planted on what might be classed as semitide lands. Most of this land was covered by débris that was deposited there during extraordinarily high tides. The results from this land were not satisfactory so far as our potato crop was concerned. The land is so salty that 4 acres of the potatoes did not come up at all, and while the balance came up quite strong, they made a weak growth after they got about 3 inches high. I think the dry weather was mainly the cause of the weak growth, there being no rain to speak of during the months of May, June, and July, but I am also satisfied that there is too much salt in this soil for potatoes to do well.

We commenced using potatoes from the field July 28, and by August 15 they were dry and mealy, but rather small, although there were quite a good many potatoes that weighed half a pound each. Some of the vines began to turn yellow by August 1, but at that time our rains commenced and they started a new growth which was more of a damage than a benefit at that stage of the crop.

We commenced harvesting the crop September 18. There were about 5½ acres left after deducting the ground that was too salty to grow anything. They yielded 480 bushels and were of fair quality, though rather small and containing a few rotten ones.

On the same kind of land as already described, on May 16, we sowed 2 acres of oats mixed with field peas and 2 acres of wheat. The wheat proved to be fall wheat, so it did not head. It made a slow growth all summer and is now a perfect mat, covering the ground completely, but there is some danger of its being winterkilled on account of its exposed location. The oats made a fine growth, attaining a height of 4 feet. The berry was large and heavy, and it commenced to ripen during the last of August, but was cut for hay.

Our next experiment was on 3½ acres that had a very heavy growth of flower-de-luce on it; also some small spruce trees, which we grubbed out. After thoroughly fitting the piece we planted it on May 24 to three varieties of potatoes, viz, Early Ohio, Early York, and Milwaukee. The Milwaukee had been chilled before they left Wisconsin, so that there were only about half that grew. All made a weak growth at first on this piece, owing to the tough sod, but improved as the season advanced. There was plenty of subirrigation in this piece, and it was the only piece

that did not suffer from the drought this season. These are being harvested at this writing, and are of fair size and good quality, being well ripened and yielding about 100 bushels per acre.

The next piece consisted of $3\frac{1}{2}$ acres of similar land; that is, the surface conditions were the same as on the previous piece, but the soil was much heavier and had a tendency to "bake" after it was plowed. Two acres of this piece were planted to Early Ohio potatoes on May 30, and the balance sowed to barley the same day. Both barley and potatoes came up weak and spindling. The potatoes were harvested September 28. They were rather small, but thoroughly ripe and of good quality, and yielded 100 bushels from the 2 acres.

The barley was eaten off about the middle of July by horses that broke into the lot, which proved to be a benefit to the crop. When the rains commenced in the fore part of August the barley started a new growth, so that by September 24 we cut it for hay. It was about $2\frac{1}{2}$ feet high, well headed out, and the berry was fairly well filled. The straw was juicy and hard to cure.

Our next attempt was to clear up an old slashing where the greater part of the timber was cut off in 1897 and 1898. The fire had swept through it and killed the remaining trees, some of which had already tumbled over. We commenced work on this piece May 31. It was a great undertaking to put in a crop that late in the season under these circumstances; but by June 15, we had 8 acres planted and June 20 we did our last seeding. It consisted of 2 acres of turnips, one-half acre ruta-bagas, and $1\frac{1}{2}$ acres of barley. The varieties of potatoes planted in this place were Early Ohio, Early York, and Milwaukee. The Milwaukee did not get quite ripe on this piece, but were of good market size and of good quality. The Early Ohio and Early York were about ripe, as the vines were quite yellow October 1. The last planting, June 15, made the most vigorous growth of vines and had also the finest tubers. We have only dug a few in this piece, but the estimated yield is 1,000 bushels. The quality is first class and the potatoes are of good market size. Some very large. If the space that is occupied by the stumps was deducted from the 8 acres, they would easily go 150 bushels to the acre. The turnips made a fine growth. We commenced pulling them for market September 6 and have plenty of them on hand yet. The ruta-bagas are small, although there are some of marketable size. They should be sown earlier in order to insure a full crop. The barley did exceptionally well, being 4 feet high, well headed, and in blossom when we cut it for hay, September 24.

On August 20 we seeded 2 acres of this same kind of land to fall wheat and 2 acres to rye, and seeded all 4 acres to timothy and alsike clover, all of which has made a vigorous growth. I have just completed an irrigating ditch to cover this tract of 16 acres, so that we shall be in better shape next year to raise a crop, if the season happens to be dry again. We seeded about 20 acres of this old slashing to timothy and clover a year ago last May, or, in other words, we scattered the seed among the logs and brush; the result is a fine stand of tame grass.

FRUIT.

I brought 30 fruit trees with me from Wisconsin last April, consisting of the following kinds: Twelve apple trees, 12 plum trees, and 6 Early Richmond cherry trees. The apple trees consisted of 6 Duchess of Oldenburg and 6 Transparent, and the plums of the Wild Goose and Wolf. They were shipped to me in Wisconsin in December, and from there forwarded to Skagway in April, and were in very poor condition on their arrival here. The result is that only 17 out of 30 lived. The Duchess are all alive, having made a healthy growth, and ripened their wood in August. Of the Transparents 4 lived, made a fair growth, and ripened their wood. The Wild Goose are all alive and made an enormous growth, but the wood is not ripened off at this writing. Most of the Wolf were virtually dead before they left the nursery, but one of them lived and made a good growth. The cherry trees from the nursery all died,

but I had also brought 6 little cherry trees from my home in Wisconsin, which made a healthy growth and ripened off the wood in August.

I set out about 200 strawberry plants on May 20. It was between life and death with them until August 1, when we had a good rain. Since then they have made a vigorous growth, until now they are the finest plants I ever raised, though I have been a grower of them the past twenty-five years. In conclusion, allow me to say that I am well pleased with our summer's experiment, and shall try to double our efforts during the coming year.

It would be hardly fair to close this report without mentioning my neighbors' success. Mr. William Workman has 6 acres of potatoes and about 12 acres of grain. The oats and barley were ripe by the middle of September, and though the wheat was green it made excellent hay. The whole was on land plowed last fall, and made a heavy growth. His potatoes were mostly Burbanks, and yielded about 200 bushels per acre, being on old ground, some of which had been manured. Mr. L. Wilson had about one-fourth of an acre of Burbank potatoes which yielded at the rate of 300 bushels per acre. They were large and of good quality. The ground had been well manured before planting.

There is but one drawback to the development of agriculture in this section of Alaska, and that is the want of title to our land and the meager amount of land allowed to a squatter. I can see no valid reason why the general land laws of the United States could not be extended to Alaska, or such portions of them as would give us a chance to acquire title to our holding, and not be continually at the mercy of the claim jumper.

H. E. Nicolai,
Dyea, Alaska.

Prof. C. C. Georgeson,
Special Agent in Charge of Alaska Investigations, Sitka, Alaska.

PRIVATE GARDENS AT SKAGWAY.

Being compelled to wait in Skagway for a boat for two days in the early part of September, I improved the opportunity to look over the private gardens in the town. I found them to be not only numerous, but excellent. There were in Skagway the past season not less than 50 private gardens, none of them very large, but most of them large enough to supply vegetables to the respective families. Potatoes were the leading crop, followed closely by cabbage, cauliflower, turnips, lettuce, radishes, carrots, and parsnips. In some cases cucumbers were also grown successfully. Flowers were also well represented. There was scarcely a dooryard in which could not be found a fine collection of the hardy annual flowers. Pansies and sweet peas seemed to be the favorites, but poppies, nasturtiums, mignonette, marigolds, larkspur and a dozen other annuals were also much in evidence. The remarkable feature was not that the residents should attempt to grow these things, but rather the extraordinary luxuriance of everything. I have seen no finer pansies and sweet peas anywhere than could be found in some of these Skagway dooryards. Fine patches of lawn could also be seen here and there. A splendid sod of close-shaven grass presented a carpet of green which could not be surpassed. Patches of red clover could be seen here and there 2 feet

high and timothy 3 feet high. All of which proves that gardening is possible in Skagway.

The following clipping was taken from the Daily Alaskan, published at Skagway, July 24, 1901. It indicates that the community is supplied with native-grown products:

LETTUCE.

For the first time in the history of Skagway native-grown lettuce and radishes are a drug on the market. There are so many good gardens this year that the novelty of home produce has ceased.

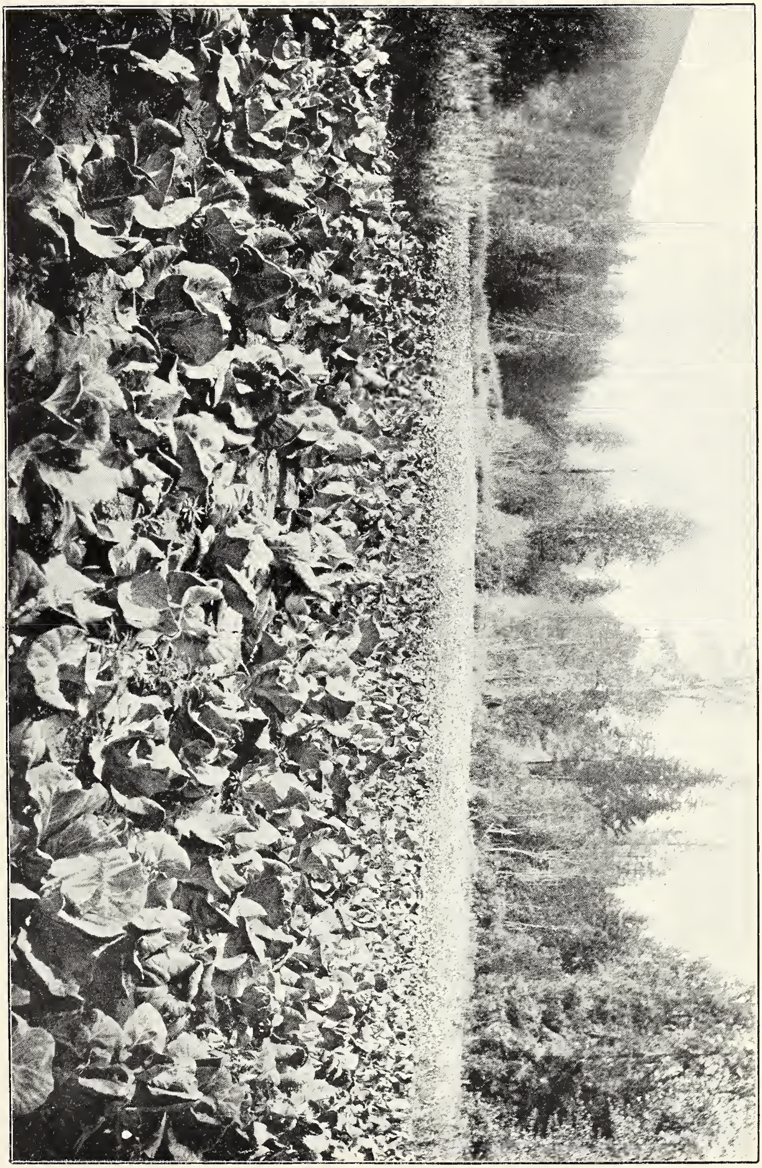
Nearly every householder has at least a small bed of lettuce and radishes, and they grow so luxuriantly and with such little care that those who have planted these succulent vegetables have a surplus to donate to their neighbors. Green peas, fresh from the gardens of Skagway, are now plentiful in the market, and young onions have been pulled daily for the past month. Anyone who is skeptical about the adaptability of Alaska for gardening need only to take a walk about the city and see the rank growth of vegetables in the kitchen gardens to gain full faith not only in the fertility of the soil, but in the adaptability of the climate for growth and maturing of the hardier varieties of vegetables.

GARDENING ON THE PORCUPINE.

The Porcupine has, since the discovery of gold, had a considerable influx of miners and prospectors. It may be explained that the Porcupine here referred to is not the Porcupine of the North which empties into the Yukon and Fort Yukon, but the region north of Haines Mission, including the territory claimed by the Canadians, and which takes its name from Porcupine Creek. The accompanying illustration (Pl. XXIV) shows in a graphic way what is being done in the line of gardening in that region. The photographs from which both plates have been reproduced have been furnished by Mr. F. F. Clarke, and they represent a view of his garden and some of his vegetables. The cabbages were planted out in the latter part of May and the photographs were taken near the middle of September, consequently the growing season would be extended by nearly another month before killing frosts would occur. The products are highly creditable not only to the grower, but to the region. Mr. Clarke furnishes the following information in regard to his garden. He states that he will have about 6 tons of strap leaf turnips, about 25 tons of ruta-bagas, and 1,200 head of cabbage, and that he raised oat hay 6 feet tall. All of these facts are of interest and speak well for the possibilities of Alaska.

LETTERS FROM SETTLERS.

I submit herewith a number of letters received from settlers in nearly all parts of the Territory. They relate for the most part to the experience of the writers with the seeds which have been sent them from the agricultural experiment station. It will be noticed that all



ALASKA STATIONS—FIELD OF CABBAGE, PORCUPINE, 1901, GROWN BY F. F. CLARKE.

are of the same tenor. Wherever the soil was in proper condition and the crops received the necessary amount of attention the results have been very satisfactory. There is no longer any doubt in regard to the possibilities of gardening in Alaska, in the interior as well as on the coast, though it is true that the experiments in the interior are as yet somewhat limited, but as a rule success has attended proper efforts.

A feature of some of these letters which merits more than passing attention is the fact that the Indians have in many instances been induced to raise gardens by the example and assistance of the white settlers in their neighborhoods. This is an encouraging feature. It fosters the hope that if the Indians could be taught how to raise the most common hardy vegetables they would in many cases do so with great benefit to themselves. The theory that the Indians will not eat vegetable food; that they mostly, and always will, live on meat and seal oil or starve has no foundation in fact. The natives will make use of any food material, though perhaps they have a preference for that which comes handy and can be obtained with the least exertion.

MUCH PLEASED WITH HER GARDEN.

SITKA, ALASKA, *October 28, 1901.*

DEAR SIR: We wish to thank you for the garden seeds furnished, and would like to report our great success.

Our garden is situated where it gets the sunshine all day. It has been well worked for four or five years. No fertilizer was used this year at all. It consists of a plat of ground 30 by 80 feet.

We commenced making our beds the 27th of April and planted lettuce and radishes. The spring was cool and the seeds were a little slow in germinating, but grew rapidly as soon as the warm days came. We continued to plant these during the summer, and still have both lettuce and radishes in abundance. Our peas were sweet and the pods well filled; turnips large and sweet, and cauliflower did remarkably well, many of the heads measuring 12 inches in diameter. The beets were exceedingly fine and grew to be quite large. We planted onion seeds, but it was a little late; but we have had an abundance of green onions all summer. Carrots, kale, and rutabagas did well, and are as fully grown as I have seen farther south. The cabbage have large, firm heads, free from worms, the pests of our neighbors farther south. At this date we have just commenced to use our parsnips; many of them over 14 inches in length, and as tender as any we have ever cooked.

We also raised two varieties of beans, which did well, ripening the 1st of September. From nine hills of potatoes we had enough to supply a family of three a month.

We have had several rows of celery, which has headed out well, and it is firm and crisp.

Strawberries did very well, and from two small rows we had enough for our family for about two weeks. We had a few raspberry bushes, from which we gathered each day enough for dessert for six weeks and also put up several jars of jam. From two or three gooseberry bushes we secured plenty of gooseberries for sauce for two weeks. We have also a few bushes of the red and white currants, which yielded an abundance of currants for table use for six weeks and over 20 pints of the most delicious jelly we ever tasted. It is a good rich color, well flavored, and solid.

We have raised from the seed six dozen asparagus plants and set them out. They

are about 6 inches high and very thrifty. This is merely an experiment, as Sitka has not an asparagus bed, but we have no doubt of its ultimate success.

Our rhubarb has been exceedingly productive and does well here. We also have parsley and an abundance of horse-radish.

There is no reason why the people of Alaska should not raise all of these vegetables, as they can be as successful here as in Oregon or Washington, and lettuce and radishes much better. Owing to the cool summers and frequent rains, vegetables do not dry out, or become pithy, and can be kept in excellent order from June till November.

Thanking you again for the seeds, I am, sincerely, yours,

Mrs. George Stowell.

Prof. C. C. Georgeson, *Sitka, Alaska.*

GOOD GARDENS AT WRANGELL.

Wrangell, Alaska, *November 1, 1901.*

Dear Sir: Last spring you were so kind as to send me some seeds, and I now wish to tell you what I think of agriculture in southeastern Alaska.

The season has been an exceptionally wet and cool one here, so I am told, and yet I have fairly good results from my garden, although I think it could have been more satisfactory had the ground been properly fertilized, as it has been in use for years, and while crop after crop has been taken from it nothing has been given back in return.

On the 18th day of June I planted peas, radishes, turnips, lettuce, carrots, and a few beans. All except the latter came on and did splendidly. From three short rows of peas we enjoyed several good messes in a large family. The radishes came on very rapidly, and had an excellent flavor and were brittle and palatable for weeks after the first came into use.

The turnips surprised everybody, they grew so rapidly and were of such fine flavor.

Within four weeks after planting we had heads of lettuce that would have done honor to any country. The turnips grew rapidly and were sweet and juicy, though when about as large around as an ordinary tea saucer they cracked open, but this did not injure them for table use.

Potatoes that I planted did only moderately well, though those put on the market here from a neighboring garden were large, well matured, and of fine flavor, some weighing 3 and 3½ pounds.

The most peculiar thing is regarding cabbage. The plants grew to a height of 18 inches and 2 feet without a sign of heading, and just when we thought of cutting them for greens begun to head, and inside of three weeks we had cabbage weighing 6 and 8 pounds and of a quality second to none.

So after watching the growth of vegetables, I am well satisfied that everything except beans, tomatoes, and cucumbers can be as successfully grown here as anywhere if proper attention is given to fertilizing and draining the ground. The soil being of a moist and chilly nature, this is very essential, as it would be on soil of a like nature in any section of the country.

I thank you most heartily for a copy of your fourth report, which I have lately received and perused with much interest. It seems to me that this report should be widely circulated, to correct the prevailing idea throughout the outside world that Alaska is a country of perpetual ice and snow; that no good can possibly come of it.

Yours, very respectfully,

A. V. R. Snyder,
Deputy Collector Customs.

Prof. C. C. Georgeson, *Sitka, Alaska.*

GOOD RESULTS AT KASSAN.

KASSAN, PRINCE OF WALES ISLAND, ALASKA,
November 1, 1901.

DEAR SIR: The seeds you so kindly sent me were duly received this spring. I planted some myself, and I gave the balance to the Indians here, as requested by you. The Indians here are the Hydahs, and all of them raise good gardens every year. As for myself, I have lived here for the past seventeen years, and I have tried a garden every year. The seeds you sent me were all good and every one came up. The carrots were fine and did well—I got 9 sacks of them; while peas, parsnips, and radishes also did well. Onions and my potatoes did not do so well. The ground I planted them on was new, and I did not expect so much this year, but will have enough for my family this winter. Next spring I shall plant a big garden.

The kale you sent me I planted in my new ground, and you never saw stuff grow as it did; we had several messes of it and gave away lots, and still there is kale left now 15 inches high.

I want to set out some blackberries, currants, and gooseberries. Can you inform me where I shall be able to get the roots? I also want some pie plant.

I inclose the names of the Indians I gave the seeds to. I have shown them how to plant them and take care of them.

I was born on a farm in Illinois and know a little about it, and as long as I live I shall try and raise a garden of some kind.

Yours, truly, W. T. BERNARD.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

GOOD RETURNS FOR LABOR.

LORING, ALASKA, *September 2, 1901.*

DEAR SIR: I desire to say with reference to seeds sent from your station, that it was quite late before I received and planted them. We had a very wet August, but my garden was very good, especially onions, radishes, lettuce, peas, and ruta-bagas. I spaded it up, and cultivated with a hoe, and fertilized with manure from cow stable. We still have plenty of rhubarb, etc.

I have no doubt alfalfa and other grass seed would do well here, and hope to try them next year. I would like to have some of your Romanow spring wheat. I am the only person at this place that has planted a garden.

I can not give amount of onions, radishes, etc., raised an acre, as I was too busy otherwise to take any measurements. The soil gave good returns for all my labor, and I shall expect to do better another year.

Respectfully, yours, F. KNIGHT.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

REPORT FROM SUMDUM.

SUMDUM, ALASKA, *April 20, 1901.*

DEAR SIR: As the season is about closed I send you my report. All of the new ground we put in this year has been a failure. The old ground has done fairly well. We raised some ruta-bagas which went as high as 7 pounds, and some white turnips are 11 inches in diameter. Cauliflower and cabbage have done well, but the onions have gone too much to tops.

I have tried some tame strawberries; they had some fruit this year of fair size. Is

there any way to kill worms? I tried some tobacco, but it did not get big. I will try again.

Where can I get a copy of land laws?

C. F. Stites.

Prof. C. C. Georgeson,
Special Agent, Sitka, Alaska.

REPORT FROM DYEA.

Dyea, Alaska, *November 14, 1901.*

Dear Sir: Your letter of the 2d instant received a few days ago, and I take great pleasure in answering it. I only wish I had more to tell you, but to tell the truth, my lack of implements necessitated some rather crude methods.

My idea at first in putting in my crop was simply to raise feed for chickens, as I meant this for a chicken ranch. I used no fertilizer, simply burning off the brush, and was astonished at my own success.

The wheat and oats were fully ripened before I cut them. I think I was most pleased with the wheat; the heads were full, and it was so heavy that I was unable to use a cradle. I intend next year to put in a larger crop, and feel confident that it will more than repay me.

Alaska has a grand future before her, I feel confident, and I am planning to make my home here for years to come. I have had my ranch platted, and intend to plant a crop on it in the spring.

Sincerely, yours,

L. Ross Stacy.

Prof. C. C. Georgeson, *Sitka, Alaska.*

A FINLANDER'S EXPERIENCE.

Seward City, Alaska, *October 8, 1901.*

Dear Sir: This spring was later than the year before. I planted potatoes from the 19th to the 25th of May. They did fairly well and are fine potatoes. Two years ago I planted potatoes on the 14th of May and had new potatoes July 8.

The ground I have been gardening on covers very nearly one acre and a half. One patch of ground is in potatoes for the third season, and did better this summer than before, and has never been manured at all. The soil is very rich, about 2 feet deep, and I think it will produce crops for many years to come without being manured. I am going to break some more ground this fall. I think it is wise to let the ground lie broken over winter. It has been tried in Finland, the country where I came from, and it seems to do the soil good. The climate over there is very nearly the same as here. I think one could raise almost any kind of vegetable here, if one had a hothouse to start the seeds in and then transplant them when the soil gets warm enough.

Potatoes grow to a pretty good size here. Some weighed a pound and a quarter. They are the finest eating potatoes I have ever had anywhere. They are far better than the potatoes brought up from the States. This can be seen from the difference in prices. Last year in Juneau the potatoes which were raised in Alaska sold for 4 cents a pound, and potatoes brought up from the States sold for 2 cents a pound.

People used to doubt if potatoes raised in Alaska would stand the winter well, but

I can say from experience that they can stand the winter far better than the potatoes that come from the States. They are in a better condition in the spring. During the winter they are just like new potatoes from the ground all winter.

I will be very much obliged to you if you will send me some more seeds. I would like to try them next spring.

Yours, truly,
FRED HANNILA.

Prof. C. C. GEORGESON,
U. S. Department of Agriculture.

SUCCEEDS IN SPITE OF ADVERSE CIRCUMSTANCES.

HOONAH, ALASKA, *October 8, 1901.*

DEAR SIR: In making report of my garden this year there are two factors tending to make my report worthless. The first is the deep snow of the preceding winter, and the second is the fact of my absence from Hoonah from July 9 to September 4. Gardens don't grow without care, and much of mine was hoed only once, and was never thinned.

Owing to the great snow—it was 20 feet deep against our house—our garden was late in being planted. My first was planted May 7, on the south of a building and with snow only a few feet distant. This produced fine lettuce, peas, wax beans, beets, and radishes. Rhubarb seeds also produced good plants. This ground had been fertilized with chicken manure and partly with ashes. It had never been planted before. Some of the beets were transplanted and did equally well.

On May 20 I dug my first parsnips of the preceding year, which had been sealed up by snow and frost during the winter. They were a good size and excellent in quality.

During the same week I planted more garden, also some flowers. This gave some nice cabbage and beets. Horehound and sage did fairly well. Celery and asparagus failed to appear, even after planting a second time. Parsley did well.

Of the flowers planted nasturtiums seem to own the country; they grow so luxuriantly. Poppies and marigolds—the latter from seeds 5 years old—gave excellent results. Mignonette and sunflowers did well. The latter have seed disks fully 6 inches in diameter, but I don't think the seeds will mature. Pansies from the seeds produced some of the finest flowers possible.

I sowed the clover seed partly on ground dug for the purpose and partly among other grass. The first has done nicely. Only a little of the other came up, as the season was dry.

My last planting was June 12—carrots, parsnips, beets, potatoes. Were not thinned, and hoed only once, so of course they are small. But I have learned that potatoes will do as well if only the skins are planted as the large pieces.

Some of the seeds were secured from Peter Henderson, but I am unable to say which varieties gave the best results. When we came here we brought a variety of peas with us in a package labeled "Klondike Seeds," which we consider a much better producer than the variety you sent. We have forgotten the name but wish we could secure it again. It grew taller and was much lighter in color than this.

Many of the natives planted seeds that you sent, but I don't know the results.

Hoping to be able next year to write more accurately, and thanking you for past favors, I am,

Sincerely, yours,

(REV.) WM. M. CARLE.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

REPORT FROM HOONAH.

Hoonah, Alaska, *October 18, 1901.*

Dear Sir: I have lived at Hoonah since the year of 1884, and have raised vegetables very successfully, making garden nearly every summer. Radishes, lettuce, beets, turnips, carrots, peas, potatoes, cabbage, and cauliflower do well.

The ordinary garden flowers do well also. I planted all the seeds you kindly sent me this summer, and nearly all came up and bloomed well, although it was a very dry summer. I planted the following seeds the last of May: Sweet alyssum, mignonette, marigold, zinnia, poppies, chrysanthemum, nasturtiums, collinsia, candytuft, sunflowers. Pansies come up from year to year. My flowers are still in bloom at this date. I wish I could bring them all in the house instead of letting the frost take them.

The U. S. S. *Gedney* was in our bay nearly all summer. I kept their table pretty well supplied with vegetables and flowers.

My flower garden was admired by every one; even the Indians would stop to gaze upon it as they passed along.

I hope you will cheer me again with some seeds next summer.

With thanks for past favors,

Yours, very respectfully,

Mrs. J. W. McFarland.

Prof. C. C. Georgeson, *Sitka, Alaska.*

EXPERIMENTS AT KODIAK BAPTIST ORPHANAGE.

Wood Island, Kodiak, Alaska, *September 25, 1901.*

As requested in your favor accompanying the seeds sent last spring, I herewith submit report of what has been accomplished with the same.

Asparagus was sown in open ground, very rich, April 27 and in cold frame April 29. Again in open ground in May. All sowings did well, but the plants in cold frame are much the best. They are a foot or more high at this writing.

Wax beans, no good.

Beets, few seeds germinated, and most plants throw up seed stock as soon as a few leaves are set.

Carrots, sown April 29 and May 7. Seed very slow in germinating; on old, rich land plants that finally appeared made large roots. Seed on rich, new soil sprouted better, but roots are small.

Cabbage, sown in cold frame April 29. Few plants are headed. Cabbage sown in boxes in the house and transplanted into cans, and then into garden, have made the best heads I have ever raised here. Some heads will weigh 6 pounds.

Cauliflower, same result as cabbage. Many plants now have a large amount of foliage, but no heads. A few have made excellent heads.

Celery from seed was worthless. Some plants secured from the A. C. Co. are making excellent showing.

Cucumbers were sown in a cold frame, and plants grew well but amounted to nothing.

Kale flourishes exceedingly well, and produces a large number of tender leaves.

Lettuce is one of the best and easiest to raise of all the vegetables. Sown in open ground April 27 and in cold frame April 29, it has kept us supplied with large, tender heads all summer. Some heads are more than a foot in diameter, and the centers have been almost as solid as cabbage for a diameter of 3 inches. The leaves do not get tough and bitter as they do in the States.

Mustard was sown May 7, and grew well, and matured seed.

Onions from seed have always been a failure here.

Parsnips, same result as with carrots.

Parsley was sown in a cold frame from April 29. It has made little progress. The seed germinated, but the leaves are small and the amount small.

Peas were planted April 27 in open ground, and have done well all summer. Seed has matured in addition to furnishing green peas for table use. Blossoms are on the vines now.

Radishes have never given trouble. They grow well and to large size. They retain their tenderness and freshness well.

Rhubarb was not planted, as we have a large number of roots, most of which have been raised from seed the past few years. Some of the stalks will measure 4 inches in circumference.

Spinach has always been a failure here. Seed stalks are sent up almost as soon as the plants are through the ground. I had two or three plants that were in good form for greens this summer.

Turnips always do well. We gathered some that weighed $2\frac{1}{2}$ pounds, and were smooth and tender.

Ruta-bagas have not done so well as turnips. The tops are very large, and they would make good forage, but roots are small.

The clovers were sown early in May, and some of the seed germinated. There are some plants now to be seen, but the stand is not good, nor do the plants look flourishing. White clover sown several years ago in our front yard is doing nicely and spreading rapidly, notwithstanding the constant tramping of the children.

Romanow spring wheat, Manshury barley, and Finnish Black oats were sown in the garden May 7, and all made a heavy growth. Some stalks of oats and barley stood 6 feet high, and the wheat was little less in height. The barley has been cut, and the yield was excellent. On 210 square feet there were $9\frac{1}{4}$ pounds of grain, which is at the rate of 40 bushels per acre.

The oats and wheat are not matured at this date, but may mature sufficiently to make seed before heavy frosts come.

Other patches of each were sown, May 29, 30, and June 1. The growth has in all cases been good, even on new soil, but none will mature except possibly a small patch of barley, which is now turning yellow. The grain could have been sown early in April had it been here, and in that case all would have stood a favorable chance of maturing.

I received a good-sized shipment of garden and farm seeds from a well-known seed company in the States, and it may interest you to know the result of planting that. As the seed did not reach here until June 10, the chances were against success, but some kinds did well.

A barrel of potatoes, consisting of Salzer Sunlight, Earliest, All the Year Round, Daughter of Early Rose, Sir Raleigh, arrived in bad condition, from being so long on the road, owing to a mistake on my part, but have proved that they are all good seed for Alaska. The yield is good and the tubers large and smooth.

Some sand vetch was tried on a sand field near the beach and is worthless.

Earliest Russian millet amounts to nothing, although tried in various localities.

Giant spurry made a good growth on good soil, but on sand did nothing.

Timothy could not be expected to do better on old or new ground.

Dwarf Victoria rape on good soil has made a good yield of forage.

Cow and hog peas in favorable places have done fairly well.

Spelt was planted on sand and on new soil. On the first it grew 14–24 inches high and was well headed, but the stand was light. On new soil the stand was better, the straw good, and the heads larger. Neither had time to mature.

I secured also some shrubs and trees as follows:

A crab apple which has made a fair growth this summer; an apple, which is

vigorous and healthy now; a plum which sent up a shoot from the root, the top being dead, but the shoot was accidently broken off; a lilac, which is now a healthy plant; two peonies, which are doing well, and a Chinese wisteria which has made the best growth of all.

The flower seeds you sent were highly appreciated, and we have had several beds of blossoms for weeks from them.

Wishing you continuation of success in your work, I am, yours sincerely,

Curtis P. Coe.

Prof. C. C. Georgeson,
Special Agent in Charge of Alaska Investigations.

REPORT FROM KADIAK.

Kadiak, Alaska, *September 26, 1901.*

Dear Sir: I wish to inform you that the seeds I received from you here turned out very well, except the cucumbers, which failed, and the onions did not get very large. The asparagus took a long time to germinate. I followed your directions in planting the seeds. The ground is a black soil, and this year I used barnyard manure, which I find very effective.

Last spring was cold and late; I did not plant my garden until the 7th of June. We have, however, had splendid weather the last month, and it still continues. The gardens are doing wonderfully well.

Yours, respectfully,

Anton Larsen.

Prof. C. C. Georgeson, *Sitka, Alaska.*

GRAIN RIPENED AT HOPE CITY.

Hope City, Cook Inlet, *October 20, 1901.*

Dear Sir: I have experimented with most of the seed you sent to me, and have had fair success with everything I planted. I will send you a sample of the wheat, oats, and barley, as it grew; sown on May 20, and ready to harvest October 1. Our season was very late here, so consequently we could not say that everything had a fair chance. I will report more fully later.

I have cleared an acre this fall and plowed the same, and hope to surprise you next fall with the samples which I shall send to you at my own expense.

Respectfully, yours,

S. C. Collins.

Prof. C. C. Georgeson, *Sitka, Alaska.*

RIPE GRAIN AND LARGE CAULIFLOWER AT AFOGNAK.

Afognak, Alaska, *October 13, 1901.*

Dear Sir: Half of the seeds you sent to me I distributed among the natives, except the barley, and the other half I used myself.

On April 15 I sowed the following seeds in a bed: Cabbage, celery, cauliflower, and kale. Set them out on beds June 4; cabbage and kale are on bed yet and growing. The cabbage is small, but passable. The kale is fine. Celery was a failure, on account of too close planting. The cauliflower is fine. The biggest head of cauliflower weighed $10\frac{1}{4}$ pounds and measured about 45 inches in circumference.

I sowed some tobacco seeds—"Connecticut Seed Leaf"—in a box. At the begin-

ning of June the plants were 3 inches tall, when I transplanted them in open ground. At the end of September I cut them down (almost 50 plants), and have them now in process of curing. The biggest leaves are 20 inches long without the stems, and the plants $3\frac{1}{2}$ feet tall.

As farmers in Finland grow tobacco successfully for their own consumption, I can not see any reason why we can not do the same in Alaska.

I sowed barley (Manshury) on May 23 on two beds. It commenced to show up June 1, headed July 27, commenced to bloom August 10. October 11, when I harvested it, the straw was still a little green, but the seeds were hard. The straw measured $3\frac{1}{2}$ feet tall.

Buckwheat (Silver Hull) seeded May 23. I raised the seed the previous summer. It came up June 5 and I gathered it October 11; matured only 10 per cent of the seeds formed after blooming.

Planted beans (Broad Windsor) May 23; they were blooming July 27, and blooming still. Plants are 4 feet tall and have pods on them; lower pods are full grown but green.

I sowed the following seeds from May 23 to May 26, besides those mentioned above: Onions (Yellow Danvers), parsley, cauliflower, rhubarb, peas, spinach, cucumber, parsnip, carrots, beets, kale, cabbage, mustard, clovers, sunflowers, caraway, sage, asparagus, lettuce, radish, turnips, ruta-baga, watermelon, and musk melon.

The biggest onion from seed measured $1\frac{1}{4}$ inches in diameter. The biggest parsnip measured $1\frac{1}{4}$ inches in diameter. The biggest carrot, $1\frac{3}{4}$ inches in diameter. The biggest beet, 4 inches in diameter. Asparagus is 6 inches tall at present. I was very successful with these vegetables, considering that the ground had been cultivated only one year.

I gathered a good lot of potatoes. It was a very bad year; the spring was late and very rainy, and the fall cloudy.

Yours, truly,

ALEXANDER FRIEDOLIN.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

EXPERIMENTS AT AFOGNAK.

AFOGNAK, ALASKA, *October 24, 1901.*

SIR: I received a great variety of seed from your station last spring, as well as the spring of 1900, and of these I have given the following trial: Romanow wheat, Manshury barley, Ligowa oats, Riga flax, red, white, and alsike clover. All were sown the 23d of May, in an old potato garden, the soil being a sandy loam, manured with kelp in the fashion it is generally done here for potatoes.

The three kinds of grain were doing surprisingly well up to the 10th of July, when cattle broke into the garden and ate off every straw clear to the ground. They grew up again very fast, however, and to my great astonishment I found the barley heading on July 24; the oats were a week later, and the wheat a few days thereafter; but the growth was stunted, of course, especially so with the barley, the straw of same not being any longer than just before it was eaten off.

On the 13th of October the barley was harvested; height about 2 feet, very even, fine heads, and seed ripe enough to germinate. On the last named date the wheat and oats were yet perfectly green, the former about 4 feet high and the latter 3.

The flax began blooming about July 24, seed nearly ripe October 13, height over 2 feet.

The clover was slow in making a start, but since it was once well up grew very fast, and the latter part of the summer the white and alsike clover looked as fine

as I have seen them anywhere, and I believe that the conditions of this region will agree with these varieties very well; but the red clover is uneven, comparatively short, and looks somewhat dried up, as though the soil was too poor for it.

In connection with my above-mentioned experiments, it must be remembered that last summer was unusually cold and rainy right through, and all planting here was two or three weeks later than ordinary seasons, where no very good results could be expected.

Very respectfully,

HERMAN V. SCHEELE.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

CATTLE DO WELL ON NATIVE FEED.

YAKUTAT, ALASKA, *November 14, 1900.*

DEAR SIR: I received last year at this mission a great many seeds from you. I have made a test of those I thought fit for the country.

I began to plant the seeds in May, and planted as much as I found time to. Some of the seeds did pretty well.

I raised fine cauliflower, cabbage, radishes, peas, lettuce, turnips, etc. Onions grow very small here, but my potatoes were large and ripened so well this year that I think I never saw better ones.

I think yearly more and more of stock raising as a business in Alaska. There are hundreds of places where grass is plentiful, and this coarse grass along the beach gives good satisfaction. It has done so for me for years back.

I keep four or five head of cattle and feed them on silage all winter, and they are all the time in good condition, and the cows give good milk. As Alaska develops there will be a growing demand for beef.

This country will soon come to the front and people will find many ways of making money in this part of Alaska. Here is plenty of fish, of course; but any one who has cattle to sell will surely find a market for them. The beef grown in Alaska is excellent.

A silo can be made very cheaply anywhere where wood is found. I made mine of boards only, and it answers the purpose very well. I do not think anybody in Alaska has better feed for cattle than my silage. I have had now beef here for nearly twelve years, and I can see a great change.

Respectfully,

(Rev.) ALBIAN JOHNSON.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

[The above letter came to me too late for last year's report.—C. C. G.]

NATIVES BEGIN TO RAISE GARDENS—LARGE DEMAND FOR SEED.

KENAI, ALASKA, *September 24, 1900.*

SIR: I will mention at the outset that we have had a very unfavorable summer. Long droughts in the spring (almost two months); cold winds. All this of course reflected upon our planting.

In regard to the cultivation of ground and planting of vegetables among the natives of Cook Inlet, I must say with great pleasure that a big step has been taken forward. Not more than three years back my parishioners, not excluding creoles, did not know how to eat lettuce, cabbage, and radishes, let alone planting any. They planted only potatoes and turnips, and this on a small scale. In some of the settlements, as Saldovia, English Bay, and Knik, there was not a single vegetable garden. At present

things are very different. Gardens have sprung up where there were none; where they were on a small scale, as at Kenai and Tyonek, they increased in dimensions.

The request for seeds is very great. What you have sent last spring was enough only for Kenai, Ninilchik, and Knik, so I was obliged to refuse people from the other four settlements. The natives of Kenai are very fond of turnips. We really need seeds by pounds and not by packages.

It would be positively a great kindness if the Government, once for all, would send some seed potatoes for some of our natives. They are very anxious to raise some potatoes, and thereby improve their material condition, but they have no seed and no money to buy any with. In this connection the Government would render the natives here a very great service, and by this better their condition and accustom them to the cultivation of vegetables. We hope, my dear Professor, that you will look upon our request with sympathy.

In conclusion we earnestly ask you to accept our sincere thanks and deep gratitude for your past kindness and attention to us.

Very respectfully, yours,

(Rev.) Ivan Bartnofsky.

Prof. C. C. Georgeson, *Sitka, Alaska.*

[The above letter arrived too late for last year's report.—C. C. G.]

FAIR RESULTS IN SPITE OF DRY SEASON.

Tyonek, Alaska, *October 28, 1900.*

Dear Sir: The present season has been extremely dry for agricultural purposes in many localities. At Tyonek during April, May, and most of July there was only about 3 inches of rainfall, and that was distributed so far apart that small seeds would not germinate. Many of the small seeds sowed in the latter part of April and first of May did not come up at all until the middle of August. Of those seeds that did come up, they made a rapid growth and matured early, considering the spring was bleak and cold. The general yield with me was the poorest in ten years, but other localities had better success. There was a fine vegetable garden raised 3 miles north of here. The mining camps of Sunrise and Hope produced excellent gardens; also the old trading station at Knik had fine gardens.

At Tyonek we had one cabbage to weigh $9\frac{1}{2}$ pounds, trimmed close. Turnips, carrots, beets, ruta-bagas, and potatoes were very fine in quality, and cauliflowers and celery also did well; but we had to sprinkle the latter with a sprinkling pot for nearly two months. Radishes and lettuce always do well.

The Indian gardens did not amount to anything, outside of their potatoes.

Very sincerely,

Thos. W. Hanmore.

Prof. C. C. Georgeson, *Sitka, Alaska.*

[This letter was received too late for last year's report.—C. C. G.]

GARDENING ON KNIK RIVER.

Knik Station, Cook Inlet, Alaska,
Via Sunrise City, October 12, 1900.

Dear Sir: Your favor of July 17 just reached me. When you learn that the nearest post-office is about 80 miles from here, and that I have to go in a small sailing boat, in perhaps the most dangerous water on the coast for small boats, you may know that I take a trip only when necessary; so my mails are few and far between.

I have received no seeds yet, and it is hardly likely that another mail will reach me this fall, as navigation will soon close for the winter.

In regard to the seeds I planted last spring, will state that my knowledge of gardening is very limited, but have had very fair success so far. I have less than an acre in cultivation.

Parsnips are the finest and largest I ever saw, and the first I have heard of being raised in the vicinity.

Turnips grow to an enormous size, and of fine flavor. (Captain Glenn took a sample of my turnips last year to Washington.) This year my seeds were bad some way, as most of them went to seed. I don't know the reason why.

The Scotch kale is a perfect success here. Two men who came here from where it is raised extensively say it was the finest they ever saw.

Cabbage is small, but heading fast at present. They have heads about the size of a pineapple cheese, and are of a fine flavor.

Ruta-bagas are large and fine; have just taken mine into the root house. I had some so big that three filled a 30-pound candy pail.

Lettuce, peas, radishes, cauliflower, and potatoes are a success.

I made a failure of cucumbers, tomatoes, spinach, and parsley, and a partial failure of onions, but I think they could be grown from seed.

The natives above raised some potatoes, turnips, kale, cabbage, cauliflower, parsnips and radishes. They are very anxious to learn. I am a very poor teacher, as I must learn myself before I can teach others. Instructions about planting should go with all the seeds you send out. Some of my failures were due to my inexperience.

Yours, truly,

G. W. PALMER.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

[Received too late for last year's report.—C. C. G.]

LARGE TURNIPS—INDIAN GARDENS.

KNIK, COOK INLET, VIA SUNRISE, ALASKA,
October 15, 1901.

DEAR SIR: Agreeable to your request I will send you a report of the seeds I planted last spring. These were the seeds you sent me a year ago. The seeds you sent me last spring were received too late for planting, so I did not try the wheat, oats, or clover seed.

The seed you sent me a year ago reached Tyonek too late to be forwarded by boat, and I had to send a native after them overland (about 100 miles or more). I have about one-sixth of an acre under cultivation and have not used any fertilizer; of course, the work has all been done by hand. I spaded the ground May 14 and 15. May 18 and 19 I planted potatoes, ruta-bagas, onions, turnips, parsnips, radishes, lettuce, beets, carrots, asparagus, peas, and mustard; of these all except the potatoes were in narrow beds. On May 30 I transplanted cabbage and cauliflower, and planted some cucumbers and beans.

Cucumbers, beans, mustard, asparagus, and onions were a failure because of dry weather. Radishes were destroyed by a white worm, which goes into the root and lives there until it is eaten up.

Lettuce, cabbage, cauliflower, and kale were not a good crop on account of dry weather in the spring. No rain fell here until July 5. I have to carry water a long way, so I do not water my plants at all.

The potatoes, turnips, parsnips, and carrots yielded well. I have 30 bushels of potatoes as fine as ever raised anywhere. One turnip weighed $17\frac{1}{4}$ pounds.

I have more than sufficient of all kinds for the winter.

Of the seeds you sent me, I gave what I did not plant myself to the natives here, and some of them raised some very good gardens, for the first working of the ground. I will give the grains a trial next year.

Clover and timothy I know will grow here, as it has come up where Captain Glenn had his hay piled, when he wintered his stock here, and is still growing, which proves that it does not kill out in the winter.

Should you send me some more seeds I will do the best I can with them. It will be a material help to the natives here to get them to raising gardens, as game seems to be getting scarcer every year, and unless the Government gives them some assistance they will, before long, have a hard time to live.

Thanking you for your past favors, I remain, yours, truly,

G. W. Palmer.

Prof. C. C. Georgeson, *Sitka, Alaska.*

REPORT FROM SUNRISE.

Sunrise, Alaska, *October 25, 1900.*

Sir: Last spring I received a package of garden seeds from you, and a circular requesting accounts of the results obtained from efforts of gardening in this vicinity.

Owing to inexperience or ignorance, only the cabbage, turnips, peas, and potatoes turned out middling well. The cabbage formed heads weighing from 8 pounds down. One of the turnips measured 2 feet ½ inch in circumference and weighed 8 pounds, all of first-class quality. The peas and potatoes did very well; particularly those planted from seed of last season came up and blossomed two weeks earlier than those from seeds obtained from the States, which would seem to indicate an advantage in planting seeds grown in Alaska.

The land is new, and three years ago was covered thickly with spruce timber, stumps measuring from 1 to 2½ feet in diameter. Soil thin on top of gravel and bowlders. Fertilized mainly by wood ashes, particularly where the large stumps were burned out.

The experiments will be continued on an enlarged scale next year. It is intended to manure the lands with horse dung, and plant onions, parsnips, carrots, beets, cauliflower, and kale, in addition to the vegetables that flourished in the patch this year.

A. Larson.

Prof. C. C. Georgeson, *Sitka, Alaska.*

GARDEN SEEDS PLANTED AT COAL HARBOR, UNGA ISLAND, ALASKA, IN 1900.

Coal Harbor, Alaska, *October 24, 1901.*

Dear Sir: Herewith please find my report upon the seeds which you sent me. Gardening with us is an old business. Some of your seeds did not do as well as they should have done, being perhaps not of the very best. The best of all would perhaps be those seeds raised from the soil where they are to be replanted. This is particularly true of potatoes and turnips. Your kale was a perfect success, continuing well into the winter months. Yearnings toward muskmelons and cucumbers are utterly hopeless, however. With us corn has proved a failure, but on the other hand, barley has matured and did well.

No. 1. Turnips, planted May 12, above ground May 21, harvested August.
No. 2. Kale, planted May 20, above ground June 1, harvested August.
No. 3. Radish, planted May 20, above ground June 1, harvested June 18.

No. 4. Parsnips, planted May 20, above ground June 2; destroyed by rats.
No. 5. Carrots, planted May 21, above ground June 8, harvested October 1.
No. 6. Potatoes, planted May 6, above ground June 21, harvested October 21.
No. 7. Lettuce, planted May 24, above ground June 5, harvested August 10.
No. 8. Cabbage, planted May 24, above ground June 8, harvested October 16.
No. 9. Onions, planted June 2, above ground June 15, harvested October 5.
No. 10. Cucumbers, planted May 20, above ground June 12, and died in a few days.
No. 11. Muskmelons, planted May 20; did not come up.
No. 12. Buckwheat, planted September, 1899, in rich and carefully prepared soil. Did not come up.
No. 13. Parsley, planted June, up in fifteen days; now in the ground, and doing well.

Remarks.

No. 1. Early White Milan variety. Well adapted to this soil and climate; grew quickly, and matured in forty days, and of good size. Cox Improved Yellow Ruta-Baga variety in the same soil, grew slowly; have not yet (October 23) matured, and have proved unsatisfactory. The Golden Ball always do well.
No. 2. Dwarf Green Curled Scotch variety has done exceedingly well; fit for use in sixty days after planting, and is still growing, and looking well.
No. 3. A perfect success. The white variety preferred.
No. 4. Thorburn Hollow Crown variety; slow growing; perhaps old seed.
No. 5. Chantenay variety. A success every way.
No. 6. California seed, Burbank. Fully matured; ripe and mealy; native seed comes up two weeks sooner.
No. 7. California seed, Prize Head, variety from E. J. Bowen, California, is the best, and last into winter.
No. 8. Early Winnigstadt variety. Quick growers, and large, but all leaves; would not head; not adapted to this climate. Small Drumhead being much better.
No. 9. Large Red Wethersfield. Do not mature except as green onions for table. Bottom sets do better.
No. 10. Early Green Prolific variety. At 1 inch above the ground died; climate too cold.
No. 11. Banquet variety. Seeds did not come up.
No. 12. Triple Curled variety. A perfect success.
No. 13. Buckwheat. Last year (1899) planted in the month of June; it grew well; height, about 2 feet. Flowers many and large, but did not pass beyond that stage. The attempt at fall planting was a total failure. Barley will grow and mature in sheltered places.

All of the above seeds were planted in the open without any forcing. The soil was composed of sandy loam, well fertilized with barnyard and stable manure, deep spaded. Under cultivation for some years. Our surplus seed was distributed to whites and natives in the neighborhood. Thus far no reports from them have reached us.

HENRY S. TIBBEY.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

ROOT CROPS DID WELL.

SAND POINT, ALASKA, *September 13, 1901.*

DEAR SIR: The package of seeds which you sent me this spring was duly received, and can now tell you something of the results.

All the root vegetables were planted on May 22, in newly broken ground with very

little fertilizer. They have all done well save the onions, which have not amounted to much.

Of the oats, wheat, and barley I planted them in old tried fertilized ground, and also planted ordinary California chicken feed wheat in the same ground.

The California wheat beat all the other seeds, that being fully headed, and about 4 feet high when I cut it. I have made ensilage of that wheat, and also made the same amount of ensilage of our native grass, and shall watch for results now as to the relative values of the two for that purpose. I will let you know as to what the outcome is.

Very truly, yours,

H. Bohtt.

Prof. C. C. Georgeson, *Sitka, Alaska.*

REPORT FROM ROLL BROTHERS HOPE CITY.

Hope City, Cook Inlet, Alaska, *April 8, 1901.*

Dear Sir: Your seeds mailed February 28 came to hand April 24. We herewith send you the following report concerning our gardening in the season of 1900.

Carrots.—Parisian Forcing and Half Long Chantenay. The Half Long Chantenay did not germinate because the ground must have been too cold. Both kinds again sown May 25, coming up June 14. A 130-foot drill row produced 60 pounds medium carrots on two-year-old good soil. Parisian Forcing proved to be about 25 pounds more productive than the other kind on the same soil and bed. Sandy rich soil proves best for carrots in this part of Alaska.

Beets.—Extra Early Eclipse Blood Turnip, and Early Bassano Blood Turnip, and Early Blood Turnip. The first-named were sown May 8, in drills, and the two other kinds were sown May 24, also in drills; 468 feet of row produced 152 pounds merchantable beets. Extra Early Eclipse proved to be the best. Early Bassano produced large tops and shaded the ground too much, therefore not good for Alaska. Beets weighed from ¼ to 1 pound.

Beans.—Extra Refugee, planted in June, seeded ⅓ pound in a 100-foot drill, on three-year-old sandy soil; had blossomed by August 1, and by August 29 they were damaged some by the frost, and produced only 1 pound very small pods September 10.

Cabbage.—Early York, Early Summer, and Late Flat Dutch. The last-named did not get solid. The season is too short for a late variety. Seed sown in a box in the house came up April 1. Seed sown in hotbed outdoors March 27 came up April 13. Cabbage transplanted May 25, June 5, also June 13. Altogether 482 plants produced 972 pounds of cabbage (merchantable cabbage). Thirty of the late kind proved to be a failure. Thirty or forty of the early kind did not head or mature. On May 28 we had a heavy snowfall, about 1½ inches, which did a good deal of damage to the plants.

All plants were set 3 feet apart each way, and we had marked the first matured cabbage on the 14th day of August.

August 14, weight of cabbage as follows: 1 head, 2 pounds; 24 heads, 80 pounds; 5 heads, 16 pounds. September 15, 1 head, 8 pounds; 1 head, 6 pounds (3 weighed 17 pounds); 1 head, 5 pounds. December 13, weight of 41 heads, 164 pounds (made into sauerkraut). Each 4 pounds. The last week in October the weather was getting too cold for cabbage. We have had about 450 pounds in our root house. The house or cabin was made of a double log wall, filled in between with 18 inches of earth. The frost penetrated in the early part of the winter, therefore we had to keep the cold out by artificial heat. We have weighed the cabbages whenever we have disposed of any of them. At this writing we have on hand 17 heads.

The following are the directions we have used in growing our cabbage plants. We take a box from 15 to 20 inches deep; put 5 inches or more of fresh horse manure in the bottom, pack it close, and next 5 to 6 inches good, rich, old soil. Sow your seed and cover with very little moist soil. Have a window or glass to cover the box with, so no warmth can escape from middle of box. Keep the box outdoors, any place, but better on the south side of the building. Cabbage seed sown in this way will come up in ten or twelve days, even if the nights are from 10 to 16 degrees below freezing. To make good, hardy plants, keep box open if the weather is too warm.

Cauliflower.—Early Snowball transplanted the same time as cabbage in good, heavy, moist soil. They grew to the size of a dinner plate. The heads are firm and of excellent flavor. Cook Inlet, the garden spot of Alaska, proves to be the home for cauliflower.

Celery.—White Plume; seed sown in a box outside March 25, and transplanted June 15. The seed did not germinate very well and we obtained only about a dozen plants. I transplanted mine in very rich four-year-old soil. The stalks proved to be of medium size.

Kale.—Proved to do very well here.

Lettuce.—Does very well here in rich, moist soil.

Onions.—They have been a failure up to this time. We have noticed a fly, or mosquito, which kills the tops of the onions from 2 to 4 inches downward, and two or three flies will be found dead on the tops of each onion. The mosquito does much damage to the growth of the onions. No doubt if the proper onions can be obtained for this climate maybe they would grow here, as the flies and mosquitoes are not any more numerous than they have been since 1896.

Potatoes.—Early Rose and White Burbank, planted May 7 and again May 20. Fifty pounds of seed were used on a space of 77 by 32 feet on new, sandy soil, and produced only 568 pounds of potatoes. We have planted from 100 to 110 pounds potatoes other years, and we have had yields of from 1,900 to 2,000 pounds. Potatoes have produced only a small crop in 1900. The reason for this was most likely the dry weather. We had 1½ inches of snow on May 28. In June and also the beginning of July it was too dry for potatoes planted in sandy soil. The potatoes attained the size of from 8 to 18 ounces, but they were a little watery.

Parsnips.—Hollow Crown. They do about as well as carrots. One hundred and thirty feet drill row produced from 45 to 50 pounds of medium size.

Radish.—Early Scarlet Turnip, White Tipped, and Olive Shaped. The early turnip or twenty-eight day radish grows well here. The Half Long or Long Radish, also called Four Weeks Radish, never has proved to be very good, except late in the autumn whenever it is cold with a good deal of rain.

Tomatoes.—Atlantic Prize Extra Early. Grown in the following way: We put the tomato seeds in the same box we grew our cabbage plants in, after the cabbage plants were removed. We kept the box covered with a window at night and cold days until the tomatoes attained the height between the earth and the glass. In this way the tomato vines have grown 3 feet high, and the fruit as large as a goose egg. The fruit did not ripen, only attained a light golden color. After keeping in the house for three or four weeks the fruit was purplish red.

Turnips.—Early White Milan, and Purple Top White Globe. Were sown May 7, came up May 20. Two hundred feet of drill produced 612 pounds on poor sandy soil. The Purple Top White Globe will get as large as from 12 to 15 pounds if not seeded too close, and it is also a good keeper. Turnips can be sown early in the spring, and the last week in June or the first week in July again. We have marketed turnips July 25. At this date they weighed 9 ounces and over.

We also will try early corn this summer.

Ruta-bagas.—Yellow or Swedish Turnips. Sown May 24 and came up June 10.

Two hundred and eighty feet of drill row produced 488 pounds. They do as well here as in the States. They attain a weight from 1 to 8 pounds, and as a rule they will average about 3 pounds.

Yours, truly,

ROLL BROTHERS,
General Merchants.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

FARMING ON THE NUSHAGAK.

MORAVIAN MISSION, NUSHAGAK, ALASKA, *August 4, 1901.*

DEAR SIR: I will drop you a few lines at this time to let you know that the thermometer and rain gauge came to hand safe and sound. I have as yet not set them up, as I have been very busy with fish catching, gardening, and haymaking, besides very many other duties; not the least of which is the post-office, of which I have charge. I shall endeavor to set them up and take records by September 1.

The seeds came all right. Some were planted, while others were kept over for next spring.

Thus far, this has been a remarkable summer, the like of which I have not seen in the five years of my Alaska life; dry and hot, so that often one felt like keeping still and cooling off.

It took a long time for the seeds to germinate, but they finally did, and now the gardens are a beautiful sight. We have very little competition in that line, so we have praise from visiting parties. We are, however, not the only ones who try to raise vegetables, as quite a number of our neighbors have gardens, and a few natives. The white settlers are all fishermen, and at the time when gardens need most attention they must be on the river catching fish. The natives, too, have spent what time they might devote to it in drinking and being "all same white man."

Everything planted seems to be doing well. Even the corn woke up during the warm weather, and if we had had some warm rain it would likely have come to something this year. I don't believe, however, that corn will do well, as a rule, here.

While I was attending to fishing, etc., the sisters waged war against the worm, which spoiled so much of our underground crop; first, wood ashes were put to all turnips and the like, but still they came. We then brought some lime from the cannery and each stalk was trenched around and a liberal pile of lime placed at the root. This checked the worms to some extent, but some go through even lime. When we dug the garden we put considerable lime on. It seems that these worms are possessed of constitutions to stand any test Alaska can furnish.

I dare say you will be interested in the growth of the grains you sent me; they are doing fine, I think. They were all planted on or soon after May 15. On account of the dryness they did not spring up very promptly, but I think most of them will mature and ripen this year. The Romanow wheat is just splendidly loaded; the oats are also doing well, but a little behind time. I have barley from a Dakota farmer which beats anything I have yet seen. Wheat (spring) from Dakota is headed, but I am afraid not as heavily as it does in its native State. I have Pennsylvania oats which is about on a par with the other.

I have sown two beds of clover, red and white, which are doing nicely, but at this writing I see no signs of blossoms. I hope it will yet mature, as clover is one of the grasses I much desire to have. I wonder how timothy grass would do here?

At last I have a cow (calf). At one of the canneries they had a cow which gave no milk, and in due season she had a calf. The men wanted to kill it at once, so they might the sooner have milk. I asked to be allowed to raise it, so am

teaching it to drink out of a bucket. It is now a week old and just begins to drink nicely. The cannery men were generous enough to give me a few quarts of milk each day, so that with a little scalded meal the calf has been faring pretty well.

I have made quite a little hay, and would have more of what I made first if it had not made me so much trouble. I think I must have put it in a little too soon, as it got too hot and molded. I had to throw it all out and dry it over, which took several days. The result is that my once fine hay is now second class. And just to-day the weather changes, and rainy weather is upon us. I think I may have a few more days of fine weather. The grass is getting very hard and coarse now.

I will not be able to build a silo this year, but hope to build a log barn as soon as I can raft the logs home. If the rains prevent any more haymaking, I will have to be satisfied with a hole in the ground for my silo.

I have tried to make use of some of the fish refuse (heads and backbone), but I am afraid my way is too offensive. I hauled a lot to the barnyard, and covered it with manure, but the flies soon had it in a terrible mess. I have heard that fish makes a good fertilizer, but I guess that I do not use it right. Can you give me advice as to how to use it?

Yours, truly,

(Rev.) S. H. Rock.

Prof. C. C. Georgeson.

[Work the fish refuse into the ground before it decays.—C. C. G.]

Moravian Mission, Nushigak, Alaska, *August 29, 1901.*

Dear Sir: I will add a few lines to what I have written under an earlier date. How I wish you could have a look at our garden. Everything is tropically inclined, I think. We have made a nice barrel of sauerkraut, and greens of all kinds have been our bill of fare for weeks.

I hope to harvest a good crop of potatoes, celery, peas, beets, and ruta-bagas. The cauliflower was lovely this year again. The lime treatment for turnips seems to have been quite a good one.

All the grains and grasses are doing splendidly, only I fear the rainy season which is upon us will hinder their full development. The barley from Dakota has fallen flat on account of heavy weight. The Romanow wheat stands all of 5 feet and is heavy with grain. The Dakota and Pennsylvania oats are also ripening.

The clover is now in blossom, but I don't think the seed will ripen; time will tell.

I sowed a bed of winter wheat which is well started now, so by next spring we will be able to report on it also. The straw of all these grains is extra heavy and of a deep green color. The Dakota wheat and Pennsylvania oats are a little behind the others.

I would like to ask what is the reason of the cabbage bursting before the head has attained any size? Many of our cabbages had to be cut on that account.

The sugar-peas planted by the sisters stand 6½ feet, and are just as full of peas as they can hang, and new blossoms are coming every day.

The American Wonder and Little Dandys are also yielding well. I think a sprinkle of lime has perhaps helped them some. They were planted on the bed where I had barley and oats last year.

If I were not so busy I would take a picture of the garden for you; may do so later.

My stock is getting along nicely. The chicks are growing nicely and the calf is beginning to nibble grass. The cow took sick a week ago and had to be killed, as nothing could be done for her. She began by limping in her right hind foot, and

someone said she had gotten foul of her rope and thrown herself and that the dogs then bit her. The dog bites, however, were very slight.

Well, I will have a litter of pigs in a few weeks, then my troubles begin anew.

Yours, truly,

(Rev.) S. H. Rock.

Prof. C. C. Georgeson, *Sitka, Alaska.*

Carmel, Nushagak River, *June 5, 1901.*

Dear Sir: The vegetable seeds that you wrote you had sent to me on February 28 arrived here June 18. Very many thanks for the same. I will be able to use only the radish and lettuce seeds this season and they are already in the ground. The others I will give a good trial next year. I also planted part of the rhubarb seeds; they are just showing, but I will watch them closely and try and raise some good ones.

The flower seeds you sent me in February I sowed also. Only the nasturtiums, pansies, and pinks have as yet come to any size, in fact most of the others are not up at all; although the phlox, poppies, petunias, and alyssum and larkspur look as though they may yet grow nicely. I hope to have some asters and mignonette for next spring. The Tom Thumb nasturtiums have done finely and are in bloom.

In looking over the seeds and list I find that there is no cauliflower. As I understand from several other parties that you sent snowball cauliflower seed to them, I feel somewhat disappointed. I have heard from parties passing through here that they are such a fine strain, and I would like to try them, but I can not get seed from Philadelphia in time for next year. I will carefully tend them and report at the end of the season.

Very truly, yours,

P. C. King.

Prof. C. C. Georgeson, *Sitka, Alaska.*

FLAX, BUCKWHEAT, AND BARLEY MATURED AT TANANA.

St. James Mission, Tanana, Alaska, *April 27, 1901.*

Dear Sir: Thanks for seeds. Will keep you posted as to what is accomplished this year. I raised last year turnips, Purple Top, 9¾ barrels from the seed sown in June, and pulled in early September the flax, buckwheat, and wheat and barley. All matured, but the stalks were very small and weak.

Yours, truly,

Alfred A. Selden.

Prof. C. C. Georgeson, *Sitka, Alaska.*

RADISHES, TURNIPS, AND LETTUCE ON KOTZEBUE SOUND.

Kotzebue, Alaska, *April 22, 1901.*

Dear Sir: Your favor of last year was received in August, 1901, consequently we have not tried the seeds. We will try this present spring, and report the results to you. With our own seeds we have only been successful with radishes, turnips, and lettuce, but think with hotbeds other things might be a success.

Yours, respectfully,

Robert Sams (Missionary).

Prof. C. C. Georgeson, *Sitka, Alaska.*

GARDENING A FAILURE AT POINT BARROW.

EAGLE, ALASKA, *July 25, 1901.*

DEAR SIR: I tried some of the seeds sent me to Point Barrow, but all results were negative. The plants grew, filled the windows with a beautiful foliage, blossomed, and died; at no period was anything edible apparent.

It is impossible to plant outside, as on the evening of the hottest day it is apt to be below freezing.

However, if more seeds are sent, I will do my best to raise something. We did not try anything but radishes and lettuce, and the latter never appeared at all.

I am on my way in after a year on the outside.

Sincerely, yours,

(Rev.) H. R. MARSH.

Prof. C. C. GEORGESON, *Sitka, Alaska.*

DISTRIBUTION OF SEEDS.

During the past year, as heretofore, hardy garden seeds, a few flower seeds, and some early maturing grains have been distributed to persons residing in the Territory who either had made application for them or who seemed likely to take an interest in their culture. This seed distribution may be regarded as legitimate experimental work. The recipients become cooperators with the experiment stations, and frequently their experience is valuable, in that it may point to a general truth. Moreover, this distribution of seeds stimulates the development of agriculture. Many people who would not have made gardens or attempted to raise crops except for the timely arrival of seeds have been induced to do so, and their example has influenced others to apply for seeds and to attempt the growing of vegetables or grains. The result is that there are gardens in hundreds of places where there otherwise would not have been any. Brief directions on their culture are sent out with the seeds for the benefit of those who have had no experience in that line, and correspondence on the subject of the cultivation of crops of every kind has been solicited and is promptly attended to.

The foregoing letters are samples of the reports which are received at the station bearing on this subject. This distribution of seed has also had the effect of encouraging the natives to engage in gardening. It is true that as yet results are but limited, but we are casting bread upon the waters, and we shall see results later on. The Indian, as a rule, has a good stock of hard common sense. When he sees that by cultivating a little patch of ground he can raise a few bushels of potatoes or turnips or anything else which will help him to eke out an existence, he is, as a rule, not averse to trying the experiment. The Indian is not an enterprising character, and probably but few of them will ever become farmers in the proper sense of the word, but his food supply in most parts of Alaska is gradually diminishing, and he is aware of this. Many settlers, as well as some of the missionaries, have expresed the view that the Indian must either take to the cultivation of the ground in order that the products of the soil may help him to obtain

a living, or else he will be a Government ward and maintained in whole or in part by the Government, if indeed he is not left to starve. The former alternative is, of course, the more preferable, and this distribution of seed is an aid to that end. For assistance in this work I depend wholly on missionaries and on well-disposed white men to whom the seed is sent and who are requested to share with the natives in their neighborhood and to instruct them how to grow the seeds. I am glad to say that many of the white people take an interest in this matter and go out of their way to help in the work.

A few flower seeds were purchased and distributed for the first time last fall. These seeds were highly appreciated, and, as a rule, they have been cultivated with much success. They have helped cheer many a home in the wilderness, and to that extent have been of real service.

I have also distributed small packages of early maturing grain, more particularly of barley and oats. Some of this grain has been sown in regions where grain had never been grown before, as, for instance, on the Tanana and in the Copper River country, and in some cases seed has been matured in spite of the fact that the ground has been new and raw. These are experiments of real value.

I recommend that the distribution of seeds be continued, and if possible extended.

The following is a copy of the instructions I sent out with the seed:

United States Department of Agriculture,
Office of Experiment Stations, Sitka, Alaska.

GENERAL DIRECTIONS FOR CULTURE.

As a guide to those who have had but little experience in growing vegetables and grain in Alaska the following suggestions are offered:

(1) As far as practicable use old ground, that is, ground which has been under culture for some years. New ground is almost invariably unproductive. It lacks available plant food and it is too sour. The seed will germinate in such soil and the young plants appear above ground, but they make but little growth, and in the course of two or three weeks they turn yellow and die. The climate is often erroneously blamed for failures of this kind.

(2) When new ground must be used its defects can in a measure be remedied by a heavy application of some good fertilizer. Fish guano has proved to be of much value at the Sitka Experiment Station for this purpose. It should be applied at the rate of about 300 pounds to the acre. Seaweed thoroughly worked into the ground is also good. Likewise stable manure and chicken dung. A dressing of quicklime will neutralize its acidity and be especially helpful to such plants as peas, beans, and the clovers.

(3) See that the ground is thoroughly drained. If good drainage can not be secured in any other way, raise the beds a foot and make them 3 feet feet wide on top and sow 2 rows of seed on each bed.

(4) Avoid thick seeding. Sow thinly in rows 2 feet apart and cover lightly. Thick seeding is not only a waste of seed, but crowded plants can not develop normally.

(5) The rows should run north and south to give the sun a chance to warm the ground between them.

(6) Stir the ground between the rows at least every two weeks, and pull all weeds when they appear.

(7) When obtainable, use fertilizers freely on old ground as well as on new.

SPECIAL DIRECTIONS FOR CULTURE.

Asparagus.—Sow in rows 2 feet apart in early spring and on very rich soil. Preferably the rows should be dug out 6 inches deep and filled with old manure before seeding. Stir the ground frequently during the summer. Late in the fall cover the plants with long manure or with hay or straw for winter protection. If the following spring the plants are strong and of good size, they can be planted out on a permanent bed; if weak and small, let them grow in the seed bed for another season and transplant them the spring following. Make a bed 3 feet wide on well-drained ground. Dig the earth 1½ feet deep, and in so doing work in a layer of stable manure a foot thick. This will raise the bed a foot. Set two rows of plants 1½ feet apart in the rows and 4 inches deep. The second year thereafter some of the more vigorous shoots may be cut. Seaweed can be used as a substitute for manure. Cover the bed every fall with manure or seaweed, and work it in in the spring, taking care not to injure the roots. The shoots will be small and spindling unless the soil is rich.

Beans, wax.—Plant in a warm, sunny place in rows 2 feet apart, but not until settled warm weather begins. They can not be counted on to produce edible beans unless grown in a dry, warm place.

Beans, Windsor.—Drop beans 4 inches apart in a row late in the spring. They are hardier than wax beans and will be successful in Alaska in all ordinary seasons. The beans are shelled and used as Lima beans when nearly full grown. They are quite equal to the latter in flavor.

Beets.—Sow very thinly in a row in early spring. When 2 inches high, thin the plants to 4 inches apart in the row.

Carrots.—Sow very thinly in a row in early spring; thin the plants to 3 inches apart.

Cabbage.—Fill a box 6 inches deep with rich, old soil and set it in a sunny window in the house. Sow the seed thinly in this about the 1st of April. Keep the plants watered and give them all the light possible. As the spring advances set the box out in sunshine during the day and shelter it at night and finally leave it out altogether. If well cared for, there will be nice plants ready to plant out about June 1. Plant on rich soil, 2½ feet apart each way. A cold frame, or, better still, a hotbed, can of course be used to raise the plants in instead of a box.

Cauliflower.—Same as cabbage.

Celery.—Raise the plants as directed for cabbage, except as follows: The seed is very fine. Sow it on the surface of the soil and cover it very lightly with sandy earth sifted over it. The plants grow slowly, but will be ready to set out by the middle of June. Set them 4 inches apart in a row, on especially rich and well-prepared soil. Blanch the stems by drawing the earth about the plants about the middle of September. Protect from early frosts.

Cucumber.—Plant seed in small pots (two seeds in a pot) in April. Keep in a sunny window or in a hotbed. Harden plants gradually during latter part of May. Plant out on rich soil in hills 2 feet apart in June. Be sure that the earth is not knocked from the roots in turning the ball out of the pot. The plants will not grow if the roots are disturbed. Cucumbers can be planted in the open in the latter part of May, but they are less certain of success than by the above plan.

Kale.—Treat as directed for cabbage and cauliflower.

Lettuce.—Sow a little in a box in early April and transplant when warm enough. Sow outdoors in May. Transplant to 6 inches apart.

Mustard.—Sow in a row in early spring and cut it for greens. Allow some of it to go to seed to supply seed for next year.

Onions.—Sow very thinly in a row on warm, well-drained soil as early as the ground can be worked. Some of the reasons for failure are too thick seeding (the plants should be at least 3 inches apart), too poor soil, and poor drainage. Save the small onions and use them for sets next year.

Parsnip.—Treat as directed for carrots; but they need more room. Plants should be at least 4 inches apart in the row.

Parsley.—Sow thinly in a row. The leaves are used for garnishing and flavoring.

Peas.—Plant in rows in early spring. Support vines with short, bushy brush.

Radish.—Sow a little in a row once every ten days from the opening of spring.

Rhubarb.—Sow thinly in a row on rich soil in early spring. Let the plants remain over winter where they grew, but protect them with a layer of hay, straw, or long manure. The following spring plant them out in some sheltered corner of the garden 3 feet apart each way on rich, well-prepared ground. With liberal manuring, winter protection, and working of the soil in summer they will last a dozen years.

Spinach.—It requires rich, well-drained soil. Sow about the middle of spring in a row.

Turnip.—Sow thinly in early spring and again about the first of July. Don't let the plants crowd each other.

Ruta-baga.—Sow thinly in rows, in early spring, and thin the plants till they are 9 inches apart.

Red clover, white clover, and Alsike clover.—A small package of each of these clovers is sent out to test them in Alaska. Sow thinly on well-prepared ground. Protect from animals. Note if they live through the winter, and if so let them go to seed and note if the seed matures. Do not mix them nor sow them with grasses of any kind.

FIELD GRAIN.

A small amount of field grain will be distributed consisting of Romanow spring wheat, Manshury barley, and Finnish Black oats and Burt Extra Early oats. These grains are sent out with a view to test their adaptability to different regions of the Territory. Those who receive them are requested to give them a careful trial on good soil. The general directions as regards soil which are given above for the culture of vegetables should be observed. Only a very small quantity of seed of each can be supplied, and it is recommended to sow it in rows 2 feet apart and hoe the rows as in the case of vegetables. Sow them as soon as danger of severe frost is over.

Romanow spring wheat.—This is the earliest spring wheat which we have so far tested at the Sitka Station. It has matured wherever tried in Alaska. It has a good straw, fine heads, with brown chaff and short beards. It was imported from northern Russia by the United States Department of Agriculture.

Manshury barley.—This variety is one of the earliest tested and has never failed to mature wherever tried. It is quite commonly cultivated throughout the Northern States.

Finnish Black oats.—The seed sent was imported from Finland in the fall of 1900. It has not been tested in Alaska, but it is believed to be as early as any variety known.

Burt Extra Early oats.—This is a variety which has matured in Alaska wherever tried. It is grown to a limited extent in the Northern States.

SAVE THE SEED.

Those who succeed in maturing these grains are earnestly requested to save the seed and to continue growing them year by year in order to obtain a stock of Alaska-grown seed. The Romanow spring wheat and the Finnish Black oats can not be supplied again.

C. C. Georgeson,
Special Agent in Charge of Alaska Investigations.

DISTRIBUTION OF TREES AND PLANTS.

I strongly recommend the distribution of trees and plants along the same lines and for the same purposes that the seed is distributed. If it is difficult for settlers to get seed under the present conditions, it is ten times more difficult for them to get plants and trees. We do not know what kind of fruits can be grown in Alaska because none has been tried. There is an old apple tree at Sitka planted by the Russians upward of forty years ago and a young tree at Wrangell. Both of these bear fruit every year, but the fruit is of inferior quality. They are the only fruit trees of bearing age I have heard of. It is of vital importance that experiments should be made in many different parts of the Territory in order to determine the possibilities in fruit growing and the delimitations of the fruit belt, if, indeed, there is one. To do this, I propose, if my plan is approved, to establish a nursery at the headquarters station, propagate all kinds of hardy fruits and send out trees and plants in limited numbers and under proper restrictions, to settlers free of charge. By this means numerous tests can be made and valuable information secured. Moreover, it will help the development of the Territory. The expense would be but a small matter to the Government, but it would mean a great deal to the pioneers. The work should be begun at once. We are ready to take it up if the appropriation makes it possible. If this feature is added to the experiment station work, it will require about $2,500 additional appropriation to procure a modest stock of trees to begin with, to pay for freight and labor, and to pay the salary of a competent, active propagator for one year.

WHAT THE DEVELOPMENT OF AGRICULTURE MEANS.

The development of agriculture in Alaska means the settlement and development of the Territory. The one line of growth is synonymous with the other. It means the building of homes, a permanent population, a powerful aid to the development of the mineral resources, the creation of wealth, and the building of a state. The mineral resources of the Territory have not been fathomed. We only know that they are vast, and that it must take a long time to exhaust them. But great as is this hidden wealth, it can not build a state unaided. If agriculture can not be, or is not developed in the Territory, Alaska must forever remain what it now is—a distant mining camp, with its base of supplies on an average nearly 2,000 miles away. The population would shift and dwindle in the placer districts with the exhaustion of the mines. Permanent settlements could be possible only in quartz mining districts, and the mines would of necessity be owned by capitalists who probably would not live there. Alaska would then be a place where the poor man could live only as the servant of the rich. If a pros-

perous and sovereign state could be born of such conditions, it would be the first instance in history. The argument has been advanced that the devolopment of agriculture would prejudice the mining interests. Such an argument is illogical and untenable. On the contrary, it would be of the greatest possible advantage to mining; it would reduce the cost of living, labor would be more plentiful, interior roads would be built, transportation facilitated, the country would be better known, and, therefore, capital for development would be more easily obtained. Nor is mining the only industry which would be benefited. The wants of the settlers would increase the business of the merchant, there would be a greater demand for transportation, the larger the population the greater would be the trade with the coast ports, the resources would be developed, and a powerful state would be added to the Union.

WORK OF THE PIONEER.

Alaska is settled by pioneers. It is the work of the pioneer which has brought her resources to light and which enables her to help in enriching the world. If Alaska ever becomes great and powerful, if the constellation of the flag is enriched by the addition of a star which shall represent Alaska, it will be due to the work of the pioneer. And by pioneer I mean not only the prospector and miner, farmer and fisherman, but also the merchant, the missionary, the mechanic, and all who by their efforts assist in the great work of development. If an agricultural industry worthy of the name is developed in the Territory, it will be due to the pioneer. His task is an arduous one. In addition to the privations and hardships which are always incident to the subduing of a new country, he has to battle with a climate which is inhospitable during a large portion of the year; he is far from home and kindred; the expenses which he has to meet for transportation and supplies are excessive, and he has to face great personal hardships. The Government has spent, and is spending, great sums in erecting military establishments in various parts of the country, all of which, of course, is an aid to its development, but the work of the pioneer is of still greater value. The writer would respectfully submit that it would be to the advantage of the Government to facilitate and assist him in the work in every way possible. Whatever facilitates the work of the pioneer goes to the benefit of the Government—it is returned in the development of the Territory. From the standpoint of the development of agriculture, I would respectfully submit that greater forward strides would be made, more would be accomplished, and the Government would, in the end, be the gainer, if the law permitted settlers to go in, and, under proper restrictions, take up 320 acres, or even only 160 acres, without cost and without the restrictions which now make it impossible for the poor man to get title to land.

SURVEYING LANDS.

The first and indeed the most essential step in the development of agriculture in Alaska is the surveying of the public lands. At present no one can get title to farming land in Alaska except by the use of soldiers' additional homestead scrip, and this costs more than the average settler can afford to pay. But when obtained it does not represent more than a small part of the total cost. The settler must at present pay the cost of the survey. This cost is excessive. United States deputy surveyors charge $15 to $20 a day, besides traveling expenses and other incidentals. So that by the time one gets title to a farm in Alaska it will have cost him as much as he can buy good improved land for in the States. As long as this condition prevails, Alaska can not be settled and agriculture can not be developed.

COOPERATIVE EXPERIMENTS ON WOOD ISLAND.

I have made an arrangement with the superintendent of the Baptist Orphanage on Wood Island, the reverend Mr. Curtis P. Coe, whereby he will cooperate with the experiment station in carrying out certain experiments. The station is to furnish him with the necessary implements, seeds, and work animals. He will then defray all of the expenses for the work and use land which belongs to the mission. A series of experiments have been planned for next year along the line of the growing of forage and grain crops.

EXPERIMENT STATION IN THE COPPER RIVER COUNTRY.

The information herewith submitted concerning the Copper River country indicates that this extensive region is perhaps the most favorable locality for agriculture in all Alaska. I recommend that a station be established there next summer. To do this, however, means the hiring of a competent assistant, the building of a house and barn, the importation of oxen or horses, and also of farming implements. These are the necessary equipments. The hiring of labor will be additional. At the least calculation all this will cost about $5,000 for the first year. The transportation of supplies from Valdez to the the interior is very expensive. Last summer it cost 50 cents per pound for transportation of supplies from salt water to Copper Center, 103 miles, and it will cost relatively more for greater distances. If my recommendation meets with approval and a station is established there, we should, of course, own the pack animals and transport the supplies ourselves.

PLANS FOR FUTURE WORK.

During the coming year it is essential that the Rampart Station should be equipped with the necessary implements for work. For that station a team of horses is needed, a wagon, two plows, a disk

harrow, a smoothing harrow, a grain drill, and hand tools of the usual kinds. To lay these things down in Rampart will cost about five times their original value on Puget Sound. In addition, a house and barn should be built, both of logs. There is plenty of timber on the reservation for this purpose. Besides these, the salary of a competent superintendent and at least two laborers during the summer season must be provided for. This meager equipment, including labor for a year, will cost about $5,000. The work which should occupy these stations will, to begin with, consist mainly in the growing of vegetables and grains in order to establish by actual tests what can be grown there, and the best methods of culture.

At the Sitka and Kenai stations the work already under way should be continued. More land must be cleared in both places and the work extended. As mentioned in the foregoing, a nursery should be established at Sitka, so that we may propagate and distribute hardy fruits to settlers for tests in various parts of the Territory.

It is also of much importance to begin work with the propagation and improvement of several of the native fruits. There are five species of huckleberries, two or three species of cranberries, a crabapple, strawberries, currants, and raspberries, all indigenous to Alaska, and all of which have merits which recommend them for domestication. The native grasses and forage plants also deserve attention, and if the funds permit, work should be undertaken with a view to establish the relative merits of the several species. Grasses of all kinds grow luxuriantly in the coast region wherever they are not driven out by the spruce. The treeless region of western Alaska has an abundant supply of grass, and stock raising is destined to become an important industry in that part of Alaska. And, as shown in this report, there are also large areas of grass land in the interior, where stock can be raised in summer and hay can be made for winter feed.

The improvements which should be made during the coming year include the following:

SITKA STATION.

1. Finishing the headquarters building in accordance with plans.
2. Furnishing a laboratory with the necessary apparatus.
3. Building of two more cottages.
4. Building a small propagating house.
5. The purchase of another yoke of oxen.
6. The purchase of three cows and a bull, as a foundation for a herd.
7. The purchase of additional implements.
8. The establishment of a nursery.
9. Extending the clearing.

KENAI STATION.

1. Extending the clearing.
2. The purchase of additional implements.

RAMPART STATION.

1. The building of a house.
2. The building of a barn.
3. The purchase and importation of a yoke of work oxen or horses.
4. The purchase and importation of the necessary implements.

ESTABLISHMENT OF COPPER RIVER STATION.

1. The selection and survey of a tract of suitable land.
2. Building a house.
3. Building a log barn.
5. The purchase and importation of a yoke of work oxen or horses.
5. The purchase and importation of the necessary implements.

SEVERAL SUBSTATIONS NECESSARY.

The vast extent of territory in Alaska and the great variation in climatic conditions make it necessary that there should be several substations. The places where stations have already been established are believed to be the best that could be selected, and a station somewhere in the Copper River country is equally necessary. I would respectfully call attention to the fact that each of these substations requires a separate equipment and a separate set of men, which multiplies the expense as compared with a single station. It is also to be noted that the equipment of the stations and the cost of labor will amount to anywhere from two to five times what it would cost to equip and work similar stations in the States. The lower rate applies to the coast stations and the higher to the interior stations.

INTRODUCTION OF DEER ON THE WESTERN ISLANDS.

My instructions directed me to ascertain in what manner it might be practicable to introduce deer on Kadiak and adjoining islands. An investigation of the subject was made, and the conclusion is that the most feasible method for the introduction of deer on these islands is to hire Indians to catch the fawns early in the spring, and when a number have been collected, ship them out and turn them loose at some place where they can be looked after and protected from dogs and hunters alike. The fawns can be obtained from almost any of the islands in southeastern Alaska, and the expense connected with the enterprise should not be great. It has been suggested that Wood Island could be made a nursery for deer. The Rev. Mr. Coe has agreed to take the matter in charge there, his mission being located on the island.

The enterprise is proposed as a measure of relief to the natives at Kadiak and elsewhere in that region. There are no deer on these islands, and with the practical extinction of the fur seal and other fur-bearing animals in that region, which have been an important source of income to the natives, they are now at times on the verge of star-

vation, a condition which the introduction of deer would probably ameliorate.

WANTON SLAUGHTER OF GAME.

In this connection I am constrained to mention that in certain parts of Alaska game is destroyed wantonly and in great number. This is the case, for instance, on the Kenai Peninsula. Hunters, not only from this country, but from foreign countries, go there and kill animals, particularly moose and mountain sheep, for the sake of the antlers and heads. I have myself met hunters of this class there every time I have been in the peninsula.

And in southeastern Alaska the Indians kill thousands of deer for the sake of the skins, which they sometimes sell as low as 20 cents apiece, though the average price is more than that. The number of deer skins bought up and exported from nearly every Indian settlement in southeastern Alaska is an index to this kind of wanton slaughter. The remedy would seem to be to prohibit the exportation of the skins and antlers of moose, caribou, mountain sheep, and deer.

WORK AS SPECIAL DISBURSING AGENT.

In order to facilitate the Alaska work, I was appointed a special disbursing agent of the Treasury Department in the summer of 1900. I have in this capacity disbursed the sums which the Treasurer of the United States has from time to time deposited to my credit in Seattle.

SOIL TEMPERATURES.

The tables submitted herewith give the detailed soil temperatures for the places and periods named. The readings are taken from two thermometers, one planted 6 inches deep and the other 24 inches. At stations which are equipped with radiation thermometers the readings of this instrument are also given. It is suspended about 6 inches above the surface of the earth and is not covered. It gives the minimum daily temperature as the vegetation feels it. There appears to be much similarity in the readings for corresponding months at each station, but the period of observation is yet too short to make generalizations.

Soil temperatures.

SITKA EXPERIMENT STATION.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1899.	°F.	°F.	°F.	1899.	°F.	°F.	°F.	1899.	°F.	°F.	°F.
May 1	42	....	....	May 7	40.5	....	....	May 13	42.5	....	......
May 2	42.5	....	....	May 8	41	....	....	May 14	42.5	....	......
May 3	41	....	....	May 9	41	....	....	May 15	43	....	......
May 4	41	....	....	May 10	41	....	....	May 16	43	....	......
May 5	41	....	....	May 11	42.5	....	....	May 17	46	....	......
May 6	42	....	....	May 12	42.5	....	....	May 18	46	....	......

Soil temperatures—Continued.

SITKA EXPERIMENT STATION—Continued.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1899.	°F.	°F.	°F.	1899.	°F.	°F.	°F.	1899.	°F.	°F.	°F.
May 19	45.5	....	....	Aug. 4	58	54	51	Oct. 20	41	45	25
May 20	46	....	....	Aug. 5	57.5	54	50	Oct. 21	40	45	24
May 21	47	43	....	Aug. 6	57.5	54	50	Oct. 22	40	45	26
May 22	48	43	....	Aug. 7	57	54	48	Oct. 23	40	45.5	24
May 23	46.5	43	....	Aug. 8	57	54.5	48	Oct. 24	40	45.5	24
May 24	45.5	43.5	....	Aug. 9	56	54	51	Oct. 25	41.5	45	38
May 25	45.5	43	....	Aug. 10	57	54	45	Oct. 26	42	44	30
May 26	45.5	43.5	....	Aug. 11	57	54	45	Oct. 27	43	44	38
May 27	45.5	43.5	....	Aug. 12	56.5	54	49	Oct. 28	43	44	40
May 28	46	43.5	....	Aug. 13	56	54	43	Oct. 29	41	44	33
May 29	47.5	43.5	....	Aug. 14	57	54	45	Oct. 30	42	44	34
May 30	47.5	43.5	....	Aug. 15	57	54	48	Oct. 31	40	44	32
May 31	46.5	43.5	....	Aug. 16	57	54	53				
June 1	47	44	32	Aug. 17	57	54	51	1900.			
June 2	48	44	32	Aug. 18	57	54	47	May 1	48	44	34
June 3	46.5	44.5	35	Aug. 19	56	54	46	May 2	47	43.5	31
June 4	46.5	44.5	35	Aug. 20	56	54	39	May 3	48	44	43
June 5	46	44.5	35	Aug. 21	55.5	54	40	May 4	47.5	44.5	42
June 6	47	44.5	35	Aug. 22	56	54	46	May 5	44	44.5	27
June 7	47.5	44.5	42	Aug. 23	55.5	54	46	May 6	46	44.5	36
June 8	47	44.5	42	Aug. 24	55	54	41	May 7	44.5	44.5	33
June 9	48	45	46	Aug. 25	55	54	40	May 8	47.5	44.5	39
June 10	48	45	43	Aug. 26	55	54	39	May 9	47	45	36
June 11	48	45	43	Aug. 27	55	54	38	May 10	47.5	45	39
June 12	49	45.5	46	Aug. 28	55	54	38	May 11	47.5	45	30
June 13	50	45.5	46	Aug. 29	55	54	46	May 12	48.5	46	33
June 14	49.5	45.5	44	Aug. 30	55	54	50	May 13	49	46	44
June 15	48.5	46	37	Aug. 31	55	54	45	May 14	49	46.5	41
June 16	49	46	36	Sept. 1	55	54	45	May 15	50	46.5	42
June 17	49	46	36	Sept. 2	54	54	44	May 16	50	46.5	42
June 18	48.5	46	36	Sept. 3	53	53.5	38	May 17	48	47	41
June 19	50	46.5	36	Sept. 4	53	53.5	40	May 18	47	47	36
June 20	50	46.5	44	Sept. 5	53	53.5	42	May 19	47.5	47	36
June 21	50	46.5	39	Sept. 6	53	53	43	May 20	49	47	41
June 22	50	46.5	38	Sept. 7	53	53	38	May 21	47.5	47	32
June 23	50.5	47	39	Sept. 8	53	53	38	May 22	50	47.5	33
June 24	50	47	38	Sept. 9	53	53	38	May 23	48	47.5	30
June 25	50	47.5	40	Sept. 10	53	53	47	May 24	48	47.5	34
June 26	52	47.5	47	Sept. 11	53	53	43	May 25	47.5	47.5	34
June 27	52.5	47.5	46	Sept. 12	53	52.5	46	May 26	50	47.5	39
June 28	52	47.5	45	Sept. 13	52	52.5	52.5	May 27	49	47.5	39
June 29	52	47.5	45	Sept. 14	52	52.5	50	May 28	49	47.5	39
June 30	51	47	44	Sept. 15	52	52.5	50	May 29	48	47.5	40
July 1	51	48	46	Sept. 16	53	52.5	45	May 30	48	47.5	37
July 2	53	48	47	Sept. 17	52	52	48	May 31	45	47.5	34
July 3	52.5	48	41	Sept. 18	52	52	50	June 1	45	47	31
July 4	53	48	48	Sept. 19	52	52	50	June 2	45	46.5	30
July 5	53	48	40	Sept. 20	52	52	50	June 3	48	47	40
July 6	54	48.5	40	Sept. 21	52	52	43	June 4	48	47	41
July 7	54	48.5	49	Sept. 22	50	52	38	June 5	51	47.5	41
July 8	54	48.5	49	Sept. 23	50	51.5	45	June 6	50	47.5	42
July 9	54.5	49	49	Sept. 24	50	51.5	43	June 7	49.5	48.5	40
July 10	55	49	49	Sept. 25	50	51	45	June 8	50	48.5	44
July 11	54.5	49.5	49	Sept. 26	50	51	42	June 9	50	48.5	42
July 12	55	50	49	Sept. 27	50	51	41	June 10	50.5	48.5	42
July 13	55	50	49	Sept. 28	50	51	38	June 11	50.5	48.5	35
July 14	55	50	44	Sept. 29	50	51	42	June 12	50	49	34
July 15	55	50	44	Sept. 30	50	50.5	38	June 13	53	49.5	38
July 16	55.5	50.5	44	Oct. 1	49	50.5	32	June 14	55	50	42
July 17	56	51	50	Oct. 2	49	50.5	45	June 15	55.5	50.5	48
July 18	56	51.5	54	Oct. 3	49	50	38	June 16	55	51	43
July 19	55	51.5	43	Oct. 4	50	50	45	June 17	54.5	50.5	42
July 20	55	51.5	52	Oct. 5	50	50	45	June 18	54.5	51.5	44
July 21	56	51.5	50	Oct. 6	49	50	38	June 19	54.5	51.5	48
July 22	56	51.5	52	Oct. 7	48.5	50	40	June 20	55	51.5	47
July 23	57.5	51.5	51	Oct. 8	47.5	49.5	34	June 21	54.5	51.5	46
July 24	57	52	53	Oct. 9	46	49	30	June 22	52.5	51.5	44
July 25	57	52.5	50	Oct. 10	44	49	30	June 23	54	51.5	46
July 26	57	52.5	49	Oct. 11	43	48.5	25	June 24	55.5	51.5	40
July 27	59	52.5	49	Oct. 12	42.5	48	24	June 25	58.5	52	45
July 28	60	53	51	Oct. 13	43	48	29	June 26	58.5	53	50
July 29	60	53	49	Oct. 14	45	48	40	June 27	58.5	53	44
July 30	60	53.5	50	Oct. 15	46	45.5	39	June 28	58.5	53	42
July 31	61	53.5	50	Oct. 16	46	47	38	June 29	58	53.5	44
Aug. 1	59	54	52	Oct. 17	46	46	38	June 30	60	54	42
Aug. 2	58	54	50	Oct. 18	42.5	45	27	July 1	63	54.5	52
Aug. 3	58.5	54	53	Oct. 19	42	45	28	July 2	59	54.5	50

Soil temperatures—Continued.

SITKA EXPERIMENT STATION—Continued.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1900.	°F.	°F.	°F.	1900.	°F.	°F.	°F.	1901.	°F.	°F.	°F.
July 3	60	54.5	49	Sept. 19	....	....	....	Apr. 6	39	42.5	28
July 4	59.5	54.5	50	Sept. 20	....	....	....	Apr. 7	39	42.5	33
July 5	55.5	54	40	Sept. 21	....	....	....	Apr. 8	39	42.5	36
July 6	57	54	42	Sept. 22	....	....	....	Apr. 9	39	42.5	30
July 7	57.5	54	42	Sept. 23	51	53	33	Apr. 10	39	42.5	31
July 8	59	54.5	46	Sept. 24	51	53	36	Apr. 11	36.5	42	29
July 9	61	55	52	Sept. 25	....	....	....	Apr. 12	36.5	42	29
July 10	58	55	40	Sept. 26	....	....	....	Apr. 13	38.5	41.5	32
July 11	58.5	55	42	Sept. 27	....	....	....	Apr. 14	39.5	41.5	31
July 12	60.5	55	47	Sept. 28	51.5	53	43	Apr. 15	40	42	33
July 13	59	55	50	Sept. 29	50	52	31	Apr. 16	39.5	41	33
July 14	59	55	49	Sept. 30	49	52	36	Apr. 17	39.5	40	33
July 15	58	55	50	Oct. 1	47.5	52	26	Apr. 18	40.5	41	32
July 16	59	55	50	Oct. 2	47	51	33	Apr. 19	42	41.5	38
July 17	57	55	51	Oct. 3	45	50	30	Apr. 20	42	41.5	34
July 18	58	55	50	Oct. 4	44	50	24	Apr. 21	44	42.5	35
July 19	56.5	54.5	51	Oct. 5	44	49	24	Apr. 22	44	43	34
July 20	55	54.5	41	Oct. 6	44.5	49	34	Apr. 23	44.5	43	34
July 21	57	54.5	46	Oct. 7	47	49	42	Apr. 24	45	44	34
July 22	57	54.5	52	Oct. 8	49.5	49	42	Apr. 25	45.5	44.5	36
July 23	57.5	54.5	52	Oct. 9	49	49	39	Apr. 26	45.5	44.5	33
July 24	58	54.5	44	Oct. 10	49	49	38	Apr. 27	46	45	41
July 25	59.5	55	49	Oct. 11	48.5	49.5	38	Apr. 28	46.5	45.5	32
July 26	58	55.5	52	Oct. 12	46.5	49	26	Apr. 29	46.5	45.5	32
July 27	58	55.5	52	Oct. 13	45.5	48	33	Apr. 30	46	45.5	37
July 28	58.5	55.5	44	Oct. 14	46	47.5	37	May 1	42	46	31
July 29	57.5	55.5	49	Oct. 15	46	47.5	33	May 2	40	46	31
July 30	57	55.5	46	Oct. 16	46	48	35	May 3	42	46	33
July 31	57	55	45	Oct. 17	45	48.5	38	May 4	44	45.5	33
Aug. 1	57	55	42	Oct. 18	44.5	48	42	May 5	44	45.5	37
Aug. 2	57.5	55	51	Oct. 19	43	48	33	May 6	45	45.5	42
Aug. 3	58	55	52	Oct. 20	41	47.5	29	May 7	45	46	35
Aug. 4	59	55.5	51	Oct. 21	41	47.5	29	May 8	45	46	31
Aug. 5	58.5	55.5	49	Oct. 22	40.5	46.5	20	May 9	46.5	46	37
Aug. 6	57.5	55.5	45	Oct. 23	40	45	26	May 10	47	46.5	34
Aug. 7	58	55.5	51	Oct. 24	39.5	44.5	33	May 11	46.5	46.5	40
Aug. 8	58.5	55.5	48	Oct. 25	39.5	44.5	33	May 12	44.5	47	37
Aug. 9	60	55.5	49	Oct. 26	39.5	44.5	32	May 13	45	47	36
Aug. 10	60.5	56	54	Oct. 27	39.5	44.5	34	May 14	45.5	47	34
Aug. 11	59	56	44	Oct. 28	39	44.5	32	May 15	46.5	47	41
Aug. 12	57.5	56	42	Oct. 29	39	44	30	May 16	47	47	38
Aug. 13	58	56	50	Oct. 30	39	44	32	May 17	47.5	47.5	40
Aug. 14	56	55.5	49	Oct. 31	39	44	30	May 18	49	47.5	34
Aug. 15	54	55.5	41	Nov. 1	39	44	31	May 19	50	48	35
Aug. 16	57	55	45	Nov. 2	38	43.5	20	May 20	51.5	48	35
Aug. 17	56	55	47	Nov. 3	38	42.5	22	May 21	51	48.5	37
Aug. 18	56.5	55	47	Nov. 4	38	42.5	34	May 22	52	49	40
Aug. 19	57	55	50	Nov. 5	39	42.5	33	May 23	51	49.5	43
Aug. 20	57.5	55	52	Nov. 6	39.5	43	40	May 24	50	50	32
Aug. 21	57.5	55	44	Nov. 7	40.5	43.5	35	May 25	49.5	50	37
Aug. 22	58	55.5	54	Nov. 8	41.5	43.5	31	May 26	48	50	38
Aug. 23	57.5	55.5	53	Nov. 9	42	43.5	34	May 27	48.5	50	38
Aug. 24	56.5	55.5	38	Nov. 10	42	43.5	36	May 28	49	50	33
Aug. 25	56	55	32	Nov. 11	41	43.5	30	May 29	49	50	38
Aug. 26	55	55	40	Nov. 12	38	43	24	May 30	49	50	37
Aug. 27	55	54.5	43	Nov. 13	37	42.5	28	May 31	50	50.5	33
Aug. 28	55	54.5	50	Nov. 14	36	42	25	June 1	50.5	50.5	35
Aug. 29	56	54.5	50	Nov. 15	36	41.5	18	June 2	51	51	39
Aug. 30	56	54.5	47	Nov. 16	....	....	....	June 3	51	51	35
Aug. 31	56	54.5	47	Nov. 17	....	....	....	June 4	50.5	51.5	41
Sept. 1	55.5	54.5	47	Nov. 18	....	....	....	June 5	51.5	51.5	44
Sept. 2	55.5	54.5	47	Nov. 19	....	....	....	June 6	52.5	51.5	40
Sept. 3	55	54.5	39	Nov. 20	....	....	....	June 7	53.5	52	45
Sept. 4	54	54.5	41	Nov. 21	....	....	....	June 8	53	52	45
Sept. 5	54	54.5	40	Nov. 22	....	....	....	June 9	53	52.5	39
Sept. 6	54	54.5	40	Nov. 23	....	....	....	June 10	52	52.5	39
Sept. 7	54	54	39	Nov. 24	....	....	....	June 11	53.5	53.5	45
Sept. 8	54.5	54	49	Nov. 25	....	....	....	June 12	53	52.5	47
Sept. 9	54.5	54	49	Nov. 26	....	....	....	June 13	52	53	43
Sept. 10	55	54	52	Nov. 27	....	....	....	June 14	52.5	53	44
Sept. 11	55.5	54	45	Nov. 28	....	....	....	June 15	53	53	44
Sept. 12	55	54	42	Nov. 29	....	....	....	June 16	54	53	48
Sept. 13	52.5	54	32	Nov. 30	....	....	....	June 17	54.5	53.5	49
Sept. 14	52.5	54	32					June 18	54	53	43
Sept. 15	52	53.5	33	1901.				June 19	54	54	44
Sept. 16	51.5	53	38	Apr. 3	39	42	32	June 20	54	54	45
Sept. 17	53	53	43	Apr. 4	39	42.5	29	June 21	54.5	54	46
Sept. 18	53.5	53	48	Apr. 5	39	42.5	25	June 22	55.5	54.5	49

Soil temperatures—Continued.

SITKA EXPERIMENT STATION—Continued.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1901.	°*F.*	°*F.*	°*F.*	1901.	°*F.*	°*F.*	°*F.*	1901.	°*F.*	°*F.*	°*F.*
June 23	55	54.5	47	Aug. 7	57.5	59.5	46	Sept. 20	54	57	46
June 24	55	54.5	49	Aug. 8	57.5	59.5	50	Sept. 21	54	57	37
June 25	57	55	48	Aug. 9	56.5	59.5	50	Sept. 22	52.5	57	37
June 26	56.5	55	45	Aug. 10	56.5	59.5	50	Sept. 23	53	57	45
June 27	56.5	55.5	45	Aug. 11	56.5	59.5	51	Sept. 24	53	57	39
June 28	55	55.5	45	Aug. 12	56.5	59.5	50	Sept. 25	53	56.5	37
June 29	54	55.5	46	Aug. 13	56.5	59.5	50	Sept. 26	52	56.5	43
June 30	54.5	55.5	47	Aug. 14	57	59	51	Sept. 27	51.5	56.5	36
July 1	54	55.5	45	Aug. 15	57	59	46	Sept. 28	51	57	36
July 2	55	55.5	45	Aug. 16	57	59	48	Sept. 29	51	56	44
July 3	56.5	55.5	45	Aug. 17	57	59	48	Sept. 30	50	55.5	44
July 4	55.5	55.5	49	Aug. 18	56	59	47	Oct. 1	52	53.5	47
July 5	56.5	56	48	Aug. 19	56	59	50	Oct. 2	52	54	45
July 6	58	56	50	Aug. 20	56	59	49	Oct. 3	52	54	41
July 7	56	56.5	46	Aug. 21	56	59	50	Oct. 4	52	54	45
July 8	55.5	56.5	46	Aug. 22	57	59	52	Oct. 5	52	54	45
July 9	55	56.5	44	Aug. 23	57.5	59	52	Oct. 6	52	54	46
July 10	56.5	56.5	48	Aug. 24	58	59	52	Oct. 7	51.5	54	44
July 11	56.5	56.5	43	Aug. 25	59	59	50	Oct. 8	51.5	53.5	45
July 12	57	56.5	56	Aug. 26	59	59.5	52	Oct. 9	51.5	53.5	43
July 13	57.5	56.5	48	Aug. 27	58.5	59.5	52	Oct. 10	51.5	53	42
July 14	56.5	56.5	48	Aug. 28	57	60	56	Oct. 11	51.5	53	44
July 15	58	57	52	Aug. 29	57	60	54	Oct. 12	51.5	52.5	44
July 16	59.5	57.5	49	Aug. 30	56	59.5	50	Oct. 13	50	52.5	38
July 17	59	58	52	Aug. 31	56	60	57	Oct. 14	48	52.5	31
July 18	58.5	58	45	Sept. 1	55.5	59.5	48	Oct. 15	48	52.5	40
July 19	60	58	51	Sept. 2	55	59.5	48	Oct. 16	49	52	42
July 20	59	58.5	47	Sept. 3	54.5	59	45	Oct. 17	49	52	33
July 21	58.5	58.5	45	Sept. 4	53.5	59	44	Oct. 18	48.5	51.5	44
July 22	60	59	53	Sept. 5	54	58.5	47	Oct. 19	48.5	51.5	45
July 23	59.5	59	49	Sept. 6	54	58.5	50	Oct. 20	48	51	43
July 24	59.5	59	46	Sept. 7	55	58.5	45	Oct. 21	48	51	41
July 25	60	59.5	53	Sept. 8	56	58.5	50	Oct. 22	47	51	40
July 26	60	59.5	52	Sept. 9	57	58.5	48	Oct. 23	46.5	51	38
July 27	60	59.5	49	Sept. 10	57	58.5	49	Oct. 24	46.5	51	31
July 28	60.5	60	50	Sept. 11	57	58.5	50	Oct. 25	46.5	50.5	38
July 29	61.5	60	49	Sept. 12	57	58.5	49	Oct. 26	46	50	41
July 30	62	60	52	Sept. 13	55.5	5.85	44	Oct. 27	46	50	38
Aug. 1	59	60.5	51	Sept. 14	53.5	58.5	45	Oct. 28	45.5	49.5	36
Aug. 2	58	60.5	49	Sept. 15	53	58	44	Oct. 29	44.5	49	36
Aug. 3	58	60.5	50	Sept. 16	53	57.5	48	Oct. 30	44	49	33
Aug. 4	57	60	49	Sept. 17	53.5	57.5	48	Oct. 31	43	49	33
Aug. 5	58	60	50	Sept. 18	54.5	57.5	46				
Aug. 6	58	60	51	Sept. 19	54.5	57.5	50				

KENAI EXPERIMENT STATION.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1899.	°*F.*	°*F.*	°*F.*	1899.	°*F.*	°*F.*	°*F.*	1899.	°*F.*	°*F.*	°*F.*
May 1	......	......	......	May 28	41	32	......	June 24	52	42	......
May 2	......	......	......	May 29	38.5	32	......	June 25	51.5	42	......
May 3	......	......	......	May 30	38	32	......	June 26	53	42.5	......
May 4	......	......	......	May 31	38.5	32	......	June 27	52	43.5	......
May 5	......	......	......	June 1	38	32	......	June 28	52	44	......
May 6	......	......	......	June 2	38	32	......	June 29	51	44	......
May 7	......	......	......	June 3	39	32	......	June 30	52	44.5	......
May 8	......	......	......	June 4	39.5	32	......	July 1	54	45	......
May 9	......	......	......	June 5	41	32	......	July 2	53	45.5	......
May 10	36	......	......	June 6	42	32	......	July 3	52.5	45.5	......
May 11	35	......	......	June 7	41	32	......	July 4	52.5	47	......
May 12	36	......	......	June 8	41.5	32	......	July 5	54	46	......
May 13	36	......	......	June 9	41.5	32	......	July 6	54.5	46.5	......
May 14	35	......	......	June 10	43	32	......	July 7	57	47	......
May 15	36	......	......	June 11	42	32	......	July 8	58	47.5	......
May 16	36	......	......	June 12	45.5	32	......	July 9	58	48.5	......
May 17	36.5	......	......	June 13	45	32	......	July 10	58	48.5	......
May 18	36.5	......	......	June 14	44.5	32	......	July 11	57	49	......
May 19	36	......	......	June 15	45	32.5	......	July 12	53.5	49	......
May 20	38	......	......	June 16	47	32.5	......	July 13	52.5	49	......
May 21	39.5	......	......	June 17	48.5	33	......	July 14	50	49	......
May 22	39	......	......	June 18	48.5	35	......	July 15	55	49	......
May 23	39	......	......	June 19	48	37.5	......	July 16	55	49	......
May 24	39	......	......	June 20	47.5	37.5	......	July 17	59	50	......
May 25	39	......	......	June 21	44.5	39.5	......	July 18	59	50	......
May 26	39	......	......	June 22	50	40.5	......	July 19	56	50	......
May 27	41	......	......	June 23	50	41	......	July 20	56	50	......

Soil temperatures—Continued.

KENAI EXPERIMENT STATION—Continued.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1899.	°F.	°F.	°F.	1899.	°F.	°F.	°F.	1901.	°F.	°F.	°F.
July 21	57.5	50	......	Oct. 4	40.5	43.5	......	Aug. 10	53	51	......
July 22	57.5	50	......	Oct. 5	41.5	43.5	......	Aug. 11	52	51	......
July 23	58	50.5	......	Oct. 6	39.5	43	......	Aug. 12	53.5	51	......
July 24	55	50	......	Oct. 7	38.5	43	......	Aug. 13	54	51	......
July 25	56	50	......	Oct. 8	38.5	43	......	Aug. 14	55.5	50.5	......
July 26	56	50	......	Oct. 9	37.5	42.5	......	Aug. 15	55	50	......
July 27	57	50	......	Oct. 10	37.5	42.5	......	Aug. 16	54	50.5	......
July 28	58	50.5	......	Oct. 11	37	42	......	Aug. 17	54	50.5	......
July 29	58	50.5	......	Oct. 12	38.5	41.5	......	Aug. 18	53	50.5	......
July 30	59	51.5	......	Oct. 13	40	41.5	......	Aug. 19	54	50.5	......
July 31	59	51.5	......	Oct. 14	38.5	41.5	......	Aug. 20	53	50.5	......
Aug. 1	58.5	52	......	Oct. 15	39.5	41.5	......	Aug. 21	53.5	50	......
Aug. 2	57	52	......	Oct. 16	39.5	41.5	......	Aug. 22	54.5	50.5	......
Aug. 3	55	52	......	Oct. 17	38.5	41	......	Aug. 23	54.5	50.5	......
Aug. 4	55	51.5	......	Oct. 18	36	41	......	Aug. 24	54	50.5	......
Aug. 5	54.5	51.5	......	Oct. 19	35	40	......	Aug. 25	54.5	50.5	......
Aug. 6	54	51.5	......	Oct. 20	......	......	......	Aug. 26	53.5	50.5	......
Aug. 7	55	51	......	Oct. 21	......	......	......	Aug. 27	53	50.5	......
Aug. 8	55	51	......	Oct. 22	......	......	......	Aug. 28	53	50.5	......
Aug. 9	55	51	......	Oct. 23	......	......	......	Aug. 29	53.5	50	......
Aug. 10	56	51	......	Oct. 24	......	......	......	Aug. 30	53.5	50	......
Aug. 11	55.5	51.5	......	Oct. 25	......	......	......	Aug. 31	53	50	......
Aug. 12	54.5	51.5	......	Oct. 26	......	......	......	Sept. 1	51.5	50	......
Aug. 13	56	51.5	......	Oct. 27	......	......	......	Sept. 2	52	50	......
Aug. 14	54	51.5	......	Oct. 28	......	......	......	Sept. 3	50.5	49.5	......
Aug. 15	54	51.5	......	Oct. 29	......	......	......	Sept. 4	49	49.5	......
Aug. 16	54	51.5	......					Sept. 5	51	49	......
Aug. 17	53	51.5	......	1901.				Sept. 6	50.5	49	......
Aug. 18	52.5	51	......	June 24	49	......	......	Sept. 7	50	49	......
Aug. 19	53	51	......	June 25	49	......	......	Sept. 8	51.5	49	......
Aug. 20	54	51	......	June 26	49.5	......	......	Sept. 9	48	49	......
Aug. 21	53	51	......	June 27	51	......	......	Sept. 10	49.5	48.5	......
Aug. 22	51	50.5	......	June 28	51.5	......	......	Sept. 11	51.5	48.5	......
Aug. 23	53	50.5	......	June 29	52.5	......	......	Sept. 12	50.5	48.5	......
Aug. 24	52.5	50.5	......	June 30	53	......	......	Sept. 13	51	48.5	......
Aug. 25	51.5	50.5	......	July 1	54.5	......	......	Sept. 14	50.5	48.5	......
Aug. 26	51.5	50	......	July 2	54	......	......	Sept. 15	48	48.5	......
Aug. 27	52	50	......	July 3	55	......	......	Sept. 16	48	48.5	......
Aug. 28	52	50	......	July 4	51	......	......	Sept. 17	48	48	......
Aug. 29	52	50	......	July 5	52	......	......	Sept. 18	47.5	47.5	......
Aug. 30	52	50	......	July 6	51.5	......	......	Sept. 19	48	47.5	......
Aug. 31	52.5	50	......	July 7	52.5	......	......	Sept. 20	49	47.5	......
Sept. 1	52.5	50	......	July 8	54.5	......	......	Sept. 21	50	47.5	......
Sept. 2	51.5	50	......	July 9	53.5	......	......	Sept. 22	49.5	47.5	......
Sept. 3	51	50	......	July 10	54.5	......	......	Sept. 23	46	47.5	......
Sept. 4	52	50	......	July 11	54.5	......	......	Sept. 24	46	47	......
Sept. 5	52	50	......	July 12	54.5	......	......	Sept. 25	44.5	46.5	......
Sept. 6	51.5	50	......	July 13	54	......	......	Sept. 26	43	46.5	......
Sept. 7	51.5	50	......	July 14	54	......	......	Sept. 27	42	46	......
Sept. 8	51	50	......	July 15	56	......	......	Sept. 28	44	45.5	......
Sept. 9	52	50	......	July 16	56	......	......	Sept. 29	44	45.5	......
Sept. 10	51.5	50	......	July 17	56.5	......	......	Sept. 30	43	45	......
Sept. 11	51	50	......	July 18	56.5	......	......	Oct. 1	41.5	45	......
Sept. 12	51.5	49	......	July 19	56.5	......	......	Oct. 2	43.5	44.5	......
Sept. 13	49	49.5	......	July 20	58	......	......	Oct. 3	45	44.5	......
Sept. 14	49.5	49.5	......	July 21	58	......	......	Oct. 4	46	44.5	......
Sept. 15	49	49	......	July 22	......	......	......	Oct. 5	44	44.5	......
Sept. 16	49.5	49	......	July 23	57.5	......	......	Oct. 6	45	44.5	......
Sept. 17	49	49	......	July 24	57.5	......	......	Oct. 7	44	44.5	......
Sept. 18	49	48.5	......	July 25	57	50.5	......	Oct. 8	44	44.5	......
Sept. 19	45.5	48.5	......	July 26	56.5	50.5	......	Oct. 9	44	44.5	......
Sept. 20	46	48	......	July 27	57.5	50.5	......	Oct. 10	43	44	......
Sept. 21	42.5	47.5	......	July 28	58.5	50.5	......	Oct. 11	41	44	......
Sept. 22	42.5	47	......	July 29	59	51	......	Oct. 12	41	43.5	......
Sept. 23	41.5	47	......	July 30	59	51	......	Oct. 13	37.5	43	......
Sept. 24	41	46	......	July 31	59	51	......	Oct. 14	39	43	......
Sept. 25	40	45.5	......	Aug. 1	58	51	......	Oct. 15	40	42.5	......
Sept. 26	42	45.5	......	Aug. 2	58.5	51.5	......	Oct. 16	39	42.5	......
Sept. 27	43	45	......	Aug. 3	58.5	51.5	......	Oct. 17	37	42	......
Sept. 28	......	......	......	Aug. 4	57	51.5	......	Oct. 18	36	42	......
Sept. 29	44	45	......	Aug. 5	56.5	51.5	......	Oct. 19	37	41.5	......
Sept. 30	41	45	......	Aug. 6	57.5	51.5	......	Oct. 20	39	41	......
Oct. 1	39.5	45	......	Aug. 7	56.5	51.5	......	Oct. 21	39	41	......
Oct. 2	39	44	......	Aug. 8	57	52	......	Oct. 22	38	41	......
Oct. 3	39.5	44	......	Aug. 9	54.5	51.5	......	Oct. 23	38	41	......

Soil temperatures—Continued.

EAGLE, ALASKA. U. G. Myers, Observer.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1900.	°*F.*	°*F.*	°*F.*	1900.	°*F.*	°*F.*	°*F.*	1901.	°*F.*	°*F.*	°*F.*
June 1	....	....	....	July 29	56	50.5	48	June 4	40	32.5	30.2
June 2	....	....	....	July 30	53.5	50.5	31	June 5	40.5	32.5	29.3
June 3	....	....	....	July 31	53.5	50.5	29	June 6	42.5	32.5	42.1
June 4	46	48.5	27	Aug. 1	53.5	50.5	29	June 7	40.5	33	31.6
June 5	48	39	31	Aug. 2	54.5	50.5	34	June 8	38	33	26.6
June 6	48.5	39.5	33	Aug. 3	53.5	50.5	32	June 9	40	33	40
June 7	48.5	40.5	29	Aug. 4	55	50.5	46	June 10	40.5	33	30.8
June 8	48	40.5	37	Aug. 5	54	50.5	42	June 11	44	33.5	40
June 9	45	40.5	25	Aug. 6	52	50.5	31	June 12	43	34	32
June 10	47	40.5	32	Aug. 7	52	50	40	June 13	44.5	34.5	33.2
June 11	45	40.5	27	Aug. 8	53.5	50	38	June 14	45	35	40
June 12	46	40.5	40	Aug. 9	54.5	50.5	39	June 15	44	35.5	30
June 13	51	40.5	45	Aug. 10	54	50,5	41	June 16	46.5	36	38
June 14	48.5	40.5	38	Aug. 11	53	50.5	42	June 17	48	37	44.2
June 15	46.5	41.5	34	Aug. 12	50	50.5	28	June 18	48.5	38	37
June 16	49	41.5	38	Aug. 13	52	50	39	June 19	48.5	38.5	45
June 17	49	41.5	33	Aug. 14	50	49.5	45	June 20	51.5	39.5	52
June 18	46	41.5	31	Aug. 15	49	49.5	28	June 21	52	40.5	43.4
June 19	49	41.5	42	Aug. 16	49	49	37	June 22	52.5	41	43.2
June 20	49	41.5	39	Aug. 17	49.5	48.5	34	June 23	52	42	43
June 21	49	42	42	Aug. 18	50.5	48.5	41	June 24	52.5	42.5	35
June 22	49.5	42	40	Aug. 19	48.5	48.5	44	June 25	54	43	46
June 23	49.5	42.5	34	Aug. 20	49	48.5	29	June 26	52	43	33
June 24	51.5	42.5	44	Aug. 21	48.5	48.5	39	June 27	52	43	36
June 25	51.5	43	45	Aug. 22	46	48.5	35	June 28	53	43.5	35
June 26	54	43.5	53	Aug. 23	45	48	29	June 29	55	44	50
June 27	58.5	44	55	Aug. 24	46.5	47.5	26	June 30	52.5	44	47
June 28	58.5	45.5	46	Aug. 25	47.5	47	34	July 1	49	43.5	44.2
June 29	58	47	47	Aug. 26	43	47	39	July 2	50	43	36
June 30	57.5	47.5	40	Aug. 27	42	47	30	July 3	51.5	43	43
July 1	60	48.5	48	Aug. 28	43.5	46	26	July 4	52.5	43	42
July 2	59	49	43	Aug. 29	44	45.5	33	July 5	51.5	43.5	41
July 3	58.5	49	44	Aug. 30	44.5	45.5	39	July 6	52.5	43.5	38.9
July 4	56.5	49	43	Aug. 31	44.5	45	42	July 7	54.5	44	41
July 5	56	49	39					July 8	54.5	44.5	46.4
July 6	55	49	37	1901.				July 9	53.5	45	36
July 7	55.5	49	40	May 13	32	18	....	July 10	55.5	45	53.5
July 8	55	48.5	42	May 14	32	19	....	July 11	53.5	45.5	37
July 9	54	48.5	37	May 15	32	18	....	July 12	53.5	45.5	39
July 10	54	48	42	May 16	32.5	20.5	....	July 13	54.5	45.5	41
July 11	51	48	38	May 17	33	34.5	....	July 14	55	46	51
July 12	51.5	47.5	32	May 18	32.5	24.5	....	July 15	55	46	50.8
July 13	53.5	47.5	36	May 19	33.5	26.3	....	July 16	55	46	52
July 14	53.5	47.5	35	May 20	34	20	....	July 17	53	46	49
July 15	54	48.5	35	May 21	35	23.2	....	July 18	53	46	43
July 16	57	49	46	May 22	36	24.4	....	July 19	53	46	35
July 17	59	49	35	May 23	39	37	....	July 20	54.5	46	49.8
July 18	55.5	49.5	37	May 24	36.5	25	....	July 21	53.5	46	40.5
July 19	53.5	49.5	46	May 25	40.5	37	....	July 22	53	46.5	37.9
July 20	52.5	49	41	May 26	40	34	....	July 23	53.5	46.5	33.1
July 21	52	48.5	32	May 27	37.5	35	....	July 24	54	46.5	33.5
July 22	52	48.5	36	May 28	38	30.4	....	July 25	54	47	34.1
July 23	52.5	48.5	42	May 29	38.5	30.5	....	July 26	54	47	37
July 24	56	48.5	47	May 30	38.5	29.5	....	July 27	54	47	39
July 25	54.5	49	38	May 31	38.5	30	....	July 28	54	47.5	44
July 26	55.5	49.5	43	June 1	39	32	34	July 29	54	47.5	44.8
July 27	57.5	50	45	June 2	38.5	32	24.5	July 30	52	47.5	41.3
July 28	57.5	50.5	50	June 3	37.5	32	23.3	July 31	52	47.5	35

FORT YUKON. Rev. L. J. H. Wooden, Observer.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1900.	°*F.*	°*F.*	°*F.*	1900.	°*F.*	°*F.*	°*F.*	1900.	°*F.*	°*F.*	°*F.*
June 1	45	31	37	June 14	43	32	29	June 27	56	36	50
June 2	46	31	42	June 15	43	32	28	June 28	58	37	54
June 3	46	31	47	June 16	43	32	43	June 29	59	37	56
June 4	47	31	44	June 17	45	32	45	June 30	59	38	59
June 5	47	31	46	June 18	46	32	47	July 1	....	....	......
June 6	46	31	45	June 19	47	32	44	July 2	....	....	......
June 7	43	31	41	June 20	47	32	46	July 3	....	....	......
June 8	40	31	36	June 21	46	32	41	July 4	....	....	......
June 9	40	31	41	June 22	47	33	43	July 5	....	....	......
June 10	41	32	36	June 23	51	33	51	July 6	53	40	51
June 11	43	32	42	June 24	51	33	50	July 7	53	41	......
June 12	45	32	44	June 25	54	34	47	July 8	52	40	40
June 13	46	32	....	June 26	56	35	55	July 9	53	40	40

Soil temperatures—Continued.

FORT YUKON—Continued.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1900.	°*F.*	°*F.*	°*F.*	1900.	°*F.*	°*F.*	°*F.*	1900.	°*F.*	°*F.*	°*F.*
July 10	54	40	44	July 28	55	43	50	Aug. 15	48	41	35
July 11	54	40	43	July 29	54	42	45	Aug. 16	48	41	45
July 12	56	40	40	July 30	55	42	38	Aug. 17	48	41	42
July 13	53	41	46	July 31	56	42	47	Aug. 18	48	40	44
July 14	58	41	46	Aug. 1	56	43	47	Aug. 19	48	40	45
July 15	59	42	56	Aug. 2	57	43	49	Aug. 20	48	40	34
July 16	58	43	49	Aug. 3	56	43	57	Aug. 21	48	40	44
July 17	59	43	....	Aug. 4	54	43	53	Aug. 22	46	40	38
July 18	53	43	50	Aug. 5	53	43	48	Aug. 23	46	40	31
July 19	54	43	52	Aug. 6	52	43	50	Aug. 24	46	39	32
July 20	54	43	52	Aug. 7	52	43	47	Aug. 25	47	39	42
July 21	53	42	48	Aug. 8	55	42	55	Aug. 26	41	39	28
July 22	55	41	45	Aug. 9	56	42	54	Aug. 27	38	39	23
July 23	56	42	46	Aug. 10	53	43	53	Aug. 28	38	37	31
July 24	55	42	54	Aug. 11	52	42	45	Aug. 29	39	37	34
July 25	55	45	48	Aug. 12	52	42	45	Aug. 30	....	....	......
July 26	56	42	50	Aug. 13	51	42	46	Aug. 31	43	36	31
July 27	56	42	49	Aug. 14	50	42	39				

HOLY CROSS MISSION.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1901.	°*F.*	°*F.*	°*F.*	1901.	°*F.*	°*F.*	°*F.*	1901.	°*F.*	°*F.*	°*F.*
June 6	35	32	35	July 5	46.5	33	38	Aug. 3	51	40	41.5
June 7	37.5	32	36	July 6	45	33.5	34	Aug. 4	50	40	41.5
June 8	37	31.5	38	July 7	47	34	35	Aug. 5	51	40	49.5
June 9	38	31.5	38	July 8	47	34	36	Aug. 6	50	40	50
June 10	40	32	35.5	July 9	48.5	34.5	47.5	Aug. 7	49.5	40	46
June 11	41.5	32	42	July 10	46.5	34.5	45	Aug. 8	45.5	40	32
June 12	40.5	32	37.5	July 11	48	34.5	48	Aug. 9	44	40	37
June 13	42.5	32	37	July 12	49	35	50	Aug. 10	43	39.5	35.5
June 14	44	32	40	July 13	49	35	48	Aug. 11	44	39.5	36
June 15	45.5	32	45.5	July 14	47.5	35.5	45.5	Aug. 12	45	39.5	37.5
June 16	45.5	32	45.5	July 15	47.5	36	40	Aug. 13	45	40	32.5
June 17	44	32	35.5	July 16	48	36	44	Aug. 14	48	40	40
June 18	46	32	44	July 17	49	36.5	44	Aug. 15	47	40	38
June 19	47	32	49	July 18	50	36.5	42	Aug. 16	48	40	37
June 20	50	32	49	July 19	50	36.5	40	Aug. 17	49	40	34
June 21	47.5	32	48	July 20	51	37	41.5	Aug. 18	47	40	32
June 22	49	32	50	July 21	58	38	52	Aug. 19	44	40	40
June 23	46.5	32	41	July 22	57	38.5	50	Aug. 20	47	40	41
June 24	48.5	32	44.5	July 23	56.5	39	48	Aug. 21	48	40	47.5
June 25	44.5	32	45.5	July 24	57	40	53	Aug. 22	48	40	46
June 26	45.5	32	47	July 25	56	40	44	Aug. 23	49.5	40	46
June 27	45	32.5	37.5	July 26	56	40.5	49	Aug. 24	48.5	41	38
June 28	47.5	32.5	44	July 27	52.5	41	47	Aug. 25	46.5	41	40
June 29	44	32	35.5	July 28	50	40.5	47	Aug. 26	46.5	41	40
June 30	43.5	32	37.5	July 29	50	40.5	45	Aug. 27	46	41	37
July 1	44	32.5	36	July 30	49	40.5	39	Aug. 28	45.5	40.5	35
July 2	47.5	32.5	47.5	July 31	49	40	32	Aug. 29	45	40.5	37
July 3	48	33	41	Aug. 1	47	40	30	Aug. 30	43	40	30
July 4	46.5	33	44	Aug. 2	50	40	39.5	Aug. 31	42	40	24

WEATHER SERVICE.

As in the past, I have also, during the period covered by this report, had supervision of the volunteer weather service on the coast, and I submit herewith condensed monthly data from the reports rendered. They indicate for each month the maximum and minimum temperatures, the daily mean temperatures, the total precipitation in inches, and the conditions of the weather as to cloudiness. The temperatures are given in degrees Fahrenheit.

The Chief of the Weather Bureau has informed me that the regular Weather Bureau station at Eagle, which was in charge of a section director of that Bureau, has been discontinued and that the stations in the interior have been directed to send their reports to me in the future.

Meteorological observations.

SITKA. F. E. Rader, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	°F.	°F.	°F.	Inches.				
May	61	29	43	4.01	3	7	21	17
June	62	33	48.3	4.99	....	9	21	16
July	87	42	56.5	2.27	6	10	15	8
August	67	40	54.5	8.35	4	7	20	14
September	68	40	51.1	8.52	4	3	23	19
October	62	30	46.3	7.90	3	5	22	17
November	57	29	43.5	7.02	2	3	25	14
December	50	21	35.4	6.94	7	4	20	11
1900.								
January	48	26	36.9	8.71	3	5	23	13
February	47	10	33	3.49	9	2	17	13
March	65	−1	37.8	2.62	9	8	14	9
April	59	30	41	12.09	5	17	8	22
May	69	31	45.4	4.56	6	21	4	19
June	71	34	51.8	3.13	9	14	7	13
July	69	45	55.4	3.77	2	16	13	16
August	67	40	55.2	7.92	2	22	7	19
September	65	32	50.9	7.82	4	16	10	14
October	58	28	42.5	10.73	3	19	9	20
November	57	15	36.4	9.39	8	7	15	14
December	52	24	37.4	6.59	....	9	22	24
1901.								
January	48	18	34	9.33	7	3	21	23
February	45	13	30.3	6.38	12	6	10	9
March	46	17	36.8	7.80	4	12	15	25
April	58	27	44.5	7.17	6	12	12	15
May	65	31	44.5	4.86	8	13	10	16
June	61	36	48.6	1.26	2	11	17	9
July	74	35	54.8	.45	8	14	9	6
August	63	39	53.7	10.03	....	5	26	25
September	65	39	51.4	8.52	3	12	15	16

KILLISNOO. Jos. Zuboff, Observer.

1899.								
January	40	11	29.4	6.41	6	3	22	20
February	42	3	26.5	4.80	3	....	25	20
March	44	8	28.6	2	12	6	13	7
April	47	27	38.6	1.60	5	3	22	8
May	54	26	40.6	1.40	8	3	20	6
June	65	37	48.7	3.20	1	9	20	10
July	71	44	56.5	.90	10	11	10	4
August	68	40	53.9	1.95	4	5	21	13
September	59	35	46.8	7.40	4	4	22	19
October	52	26	38.5	5.95	4	4	23	22
November	49	25	37.8	6.30	1	3	26	24
December	40	16	29.2	3.45	6	9	16	15
1900.								
January	42	11	31	5.55	3	6	22	17
February	42	10	29.9	3.35	9	4	15	12
March	50	−2	32.4	2.40	13	3	15	12
April	53	27	40.8	6.85	4	5	21	21
May	60	40	46.2	2.20	7	8	16	10
June	71	33	50.1	4.30	8	6	16	11
July	74	46	57.8	8.45	4	12	15	12
August	70	36	54.2	2.30	1	10	20	16
September	60	35	48	4.25	5	7	18	18
October	54	28	39.5	6	2	5	24	23
November	45	10	31.8	7.05	11	2	17	15
December	45	20	34.1	6.50	....	5	26	19
1901.								
January	37	13	27	6.95	6	4	21	20
February	41	9	23.2	6.05	11	5	12	11
March	43	12	34.6	5.40	2	6	23	17
April	45	23	36	1.15	2	10	18	7
May	61	31	42.8	4	4	10	17	15
June	65	34	51.3	1.60	4	14	12	5
July	71	43	57.6	1.40	6	14	11	8
August	66	40	51.5	5.95	....	9	22	20
September	63	36	49.9	5.50	....	9	21	17

Meteorological observations—Continued.

JUNEAU. John McLaughlin, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	*°F.*	*°F.*	*°F.*	*Inches.*				
January	44	4	27.4	4.22	11	15	5	17
February	42	4	26	3.81	15	18	....	13
March	44	10	29.2	1.58	9	9	13	10
April	52	30	40	4.28	6	3	21	19
May	69	29	45	4.68	4	23	4	15
June	68	40	52	5.63	4	8	18	20
July	86	48	62	1.06	18	8	5	7
August	71	42	56	4.88	6	11	14	16
September	66	36	50.3	9.10	5	3	22	23
October	58	26	40.4	11.90	10	6	15	18
November	56	28	40.6	6.71	7	7	16	18
December	48	11	31.4	8.32	13	12	6	16
1900.								
January	40	12	30.6	8.52	11	11	9	20
February	40	10	29	4.09	13	8	7	9
March	61	−5	33.8	3.06	20	7	4	12
April	61	30	41.3	11.37	6	4	20	23
May	64	36	47.2	5	9	10	12	18
June	76	36	53.9	2.27	14	6	10	9
July	77	45	56.2	5.19	7	11	13	12
August	71	39	54.8	6.57	9	4	18	18
September	65	34	50.4	10.84	12	4	14	16
October	55	28	41.5	10.91	10	2	19	20
November	49	10	32.9	12.45	12	6	12	13
December	49	9	32	7.87	3	7	21	25
1901.								
January	40	10	28	9.57	8	3	20	21
February	44	13	26	6.32	16	2	10	8
March	48	16	36	8.23	10	4	17	17
April	55	28	40	8.39	14	3	13	13
May	67	33	46	3.57	10	9	12	17
June	69	39	53.3	1.93	8	10	12	11
July	79	40	57	1.98	15	4	12	12
August	67	45	53.7	14.04	2	2	27	22
September	65	36	49.5	11.41	7	6	17	18

SKAGWAY. George Sexton, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
January	40	− 2	22.2	0.94	18	4	9	8
February	44	− 9	19.2	.88	17	3	8	3
March	47	1	23.4	.13	22	3	6	2
April	61	16	41.4	.66	11	18	1	8
May	77.5	25	47.1	1.07	14	11	6	7
June	80	34	54	1.29	10	11	9	11
July	92	41	61.4	.59	19	7	5	3
August	....	....	....	....	....	....	....	....
September	76	30	50	4.68	5	9	16	17
October	53	16	35.7	3.05	10	15	6	10
November	49	24	35.7	2.62	9	6	15	10
December	45	− 1	23.5	1.44	16	4	11	9

SKAGWAY. J. T. Hayne, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.								
January	42	0	17.9	0.86	10	13	8	7
February	41	− 3	23.6	.16	24	2	2	1
March	63	10	29.4	1.00	24	4	3	2
April	58	21	40.4	4.12	10	10	13	13
May	65	30	49	.12	23	6	2	3
June	93	37	58.6	.20	21	8	1	1
July	84	40	59.6	1.70	20	6	5	4
August	75	38	57.9	0	15	15	1	0

Meteorological observations—Continued.

ORCA. Capt. O. J. Humphrey, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	°F.	°F.	°F.	Inches.				
June	77	35	51.1	....	19	1	10	9
July	86	46	61	....	15	2	14	14
August	78	41	57.1	....	11	11	7	9
September	74	31	49.2	13.90	....	....	....	....
October	59	26	38.8	17.87	12	1	18	14
November	48	28	34.4	13.02	4	5	21	16
December	47	10	28.2	9.95	12	3	16	13
1900.								
January	43	10	27.4	9.78	9	0	22	16
February	41	15	30.4	9.93	13	1	14	11
March	57	10	35.9	15.74	16	3	12	10
April	64	25	39.6	16.35	6	2	22	22
May	64	28	43.7	13.70	3	8	20	20
June	....	....	....	4.59	13	4	13	11
July	....	....	....	5.06	9	9	12	13
August	....	....	....	11.25	6	8	17	19
September	....	....	....	15.32	11	1	18	14
October (25 days)	53	25	37.8	7.68	10	3	16	17
November	47	14	28.9	4.75	16	3	11	7
December	47	7	29	13.9	10	3	18	15
1901.								
January	40	9	27.1	16.17	13	1	17	16
February	38	8	25	1.21	13	2	13	5
March	50	11	34	16.91	6	2	23	22
April	....	....	....	....	....	....	....	....
May	....	....	....	....	....	....	....	....
June	....	....	....	....	....	....	....	....
July	79	33	53	3.86	11	8	12	9
August	71	41	52.7	27	3	....	28	22
September	74	35	49.6	26.3	10	....	20	19

FORT LISCUM (VALDEZ). James B. Jackson, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.								
November	50	0	22.4	2.85	....	....	....	6
December	39	− 8	21.6	4.82	....	....	....	9
1901.								
January	41	− 1	23.8	9.4	10	7	14	13
February	41	− 12	15.5	.80	16	8	4	3
March	52	10	30.8	6.38	8	8	15	18
April	50	19	31.6	6.20	13	4	13	12
May	57	27	39.4	1.45	23	1	7	4
June	67	32	49.6	1.13	18	....	12	10
July	73	32	50.5	4.77	22	....	9	9
August	63	30	46.6	16.21	2	1	28	28

KENAI. H. P. Nielsen, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
May	60	22	41	8.20	8	10	13	9
June	68	31	47.9	6.80	13	8	8	7
July	82	31	54.1	1.36	12	8	10	9
August	66	28	51.9	2.34	10	12	9	15
September	73	17	46.3	4.15	7	9	14	13
October	51	10	34.7	4.32	6	6	19	12
November	44	3	27.2	.32	6	6	18	4
December	41	−14	13	.67	14	7	10	6
1900.								
January	38	−26	7.8	1.47	15	8	8	7
February	44	−10	22.9	.31	10	4	14	4
March	52	− 8	30	.32	15	8	8	3
April	58	10	35.2	.52	8	8	14	11
May	60	21	42.7	.37	7	7	17	6
June	77	30	48.8	.55	5	0	25	4
July	72	33	54.9	.86	6	13	12	5
August	66	29	51.8	3.92	8	7	16	16
September	65	21	46.38	3.34	15	4	11	12
October	54	− 5	32.24	2.19	6	10	15	8

Meteorological observations—Continued.

KENAI. H. P. Nielsen, Observer—Continued.

Month.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Daily mean.	Total precipitation.	Weather conditions (number of days). Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°F.	°F.	°F.	Inches.				
November	34	−26	13.3	0.90	14	5	11	6
December	42	−32	14.9	1.15	11	3	15	7
1901.								
January	45	−36	11.7	.64	15	3	12	6
February	37	−28	14.2	.07	13	8	7	1
March	50	−21	28.4	.32	6	12	11	7
April	51	10	32.9	.85	14	4	12	6
May	63	23	42.1	.30	18	7	6	2
June	69	29	50.8	.06	13	6	11	1
July	80	30	52.7	1.76	12	4	15	10
August	73	31	52.5	4.75	3	12	16	16
September	62	19	46.5	2.27	13	4	13	14

TYONEK. Thomas W. Hanmore, Observer.

1899.								
January	34	− 8	5.41	1	19	7	5	6
February	38	−12	15.3	.85	17	....	11	6
March	48	− 4	23.6	.65	22	....	9	2
April	52	22	37.7	1.43	19	5	6	3
May	60	30	43.1	1.05	13	10	8	5
June	68	34	53.1	1.20	24	1	5	4
July	82	45	58.7	....	18	3	10	9
August	71	38	56.4	2.72	10	8	13	17
September	70	29	49	5.51	9	11	10	14
October	52	18	35.4	4.02	9	11	11	12
November	44	7	29.2	.58	10	10	10	3
December	41	0	17	.73	20	4	7	3
1900.								
January	35	0	13.4	2.69	15	4	12	6
February	39	1	23.7	.52	14	4	10	6
March	58	1	31.9	.59	17	5	9	5
April	56	11	35.5	.60	9	10	11	6
May	68	33	45.4	.29	12	8	11	5
June	82	40	52.9	.72	23	0	7	6
July	75	40	57	1.05	18	7	6	5
August	73	31	54.6	4.94	10	5	16	17
September	67	32	48.7	4.22	14	7	9	11
October	61	10	36.3	1.87	16	3	12	8
November	34	− 6	16.6	.60	18	4	8	3
December	42	− 17	13.9	1.54	15	2	14	7
1901.								
January	38	− 19	14.9	1.55	18	3	10	9
February	36	− 17	29.3	.20	16	2	10	5
March	46	− 3	33.5	.62	12	5	14	6
April	56	12	33.5	1	19	3	8	5
May	67	22	45.3	.04	25	4	1	1
June	74	33	53.8	.53	15	9	6	7
July	83	38	59	2.68	18	5	8	8
August	62	37	51.7	5.77	5	9	17	17

KADIAK. William J. Fisher, Observer.

1899.								
January	51	− 1	25.3	4.72	10	2	9	16
February	52	5	33.5	4.44	7	3	18	14
March	64	11	36	4.17	18	4	9	11
April	61	23	35.9	3.02	15	2	13	14
May	62	24	44.5	4.97	15	5	11	14
June	76	34	54	2.11	20	2	8	9
July	82	41	59.4	.82	19	3	9	7
August	75	41	58.2	2.37	20	3	8	10
September	....	....	....	....	....	....	....	....
October	59	31	43.3	6.31	13	2	16	19
November	53	23	38.4	5.57	7	0	23	19
December	....	....	....	....	....	....	....	....

Meteorological observations—Continued.

KADIAK AND WOOD ISLAND. Curtis P. Coe, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°F.	°F.	°F.	Inches.				
January (27 days)	49	0	28.25	2.95	7	2	18	10
February	49	20	35.4	6.19	9	0	19	19
March	51	18	37.92	7.46	9	5	17	18
April	54	11	37.8	2.60	12	5	12	12
May	64	30	44.8	6.62	7	8	16	16
June	71	39	51.6	3.35	12	2	16	9
July	68	45	54.94	6.64	8	5	18	12
August	70	42	56.6	2.74	9	8	14	17
September	68	36	50.4	1.95	......	......	......	12
October (25 days)	63	22	41.9	1.85	4	4	18	9

WOOD ISLAND. Curtis P. Coe, Observer.

1900.								
October	63	22	42.2	1.86	4	4	18	9
November	54	9	31.9	2.28	14	2	14	5
December	49	12	31.7	4.73	11	5	15	9
1901.								
January	47	7	30	2.65	11	6	14	9
February	58	4	30.6	.30	15	10	3	3
March	54	5	34.8	3.85	5	8	18	18
April (16 days)	55	17	36.4	4.20	10	3	3	8
May	63	20	43.2	3.45	15	3	13	16
June	73	37	51.2	4.50	15	3	12	11
July	79	42	55.3	3.56	14	3	14	8
August	70	43	54.6	5.13	4	5	22	19

COAL HARBOR, UNGA ISLAND. H. S. Tibbey, Observer.

1899.								
January	45	−6	26.3	3.30	10	6	15	13
February	45	0	31.9	3.77	8	3	17	14
March	48	5	34.6	4.04	10	14	7	12
April	50	25	35.8	1.82	5	3	22	14
May	54	20	39.5	3.72	5	4	22	14
June	65	15	40	.39	18	1	11	4
July	79	40	54.9	6.21	12	5	14	12
August	69	42	54	4.87	5	4	22	10
September	66	32	48.7	4.99	5	3	22	11
October	58	31	43.6	5.04	7	2	22	18
November	49	21	36	1.91	10	0	20	6
December	46	5	27.9	.70	5	4	22	4
1900.								
January	46	0	28.1	2.69	5	2	24	8
February	51	17	35	4.33	3	0	25	16
March	53	10	33.4	2.09	11	3	17	8
April	47	10	32.3	15.53	1	9	20	19
May	57	24	40.7	2.16	2	14	15	8
June	69	36	49.5	1.88	1	6	23	6
July	69	40	51.6	2.91	5	7	19	17
August	69	42	54.2	5.74	0	4	27	16
September	64	34	49.4	4.65	3	7	20	13
October	60	25	43	5.35	......	4	27	24
November	56	18	36	7.98	4	5	21	19
December	47	13	31	3.20	8	3	20	18
1901.								
January	47	11	31	4.15	9	5	17	14
February	49	−2	29	6.36	7	3	18	16
March	48	7	27.6	1.98	3	6	22	16
April	50	12	31.8	3.54	2	7	21	19
May	57	22	38.7	.66	8	8	15	9
June	61	29	45.3	2.21	10	4	16	14
July	69	38	51.9	1.64	8	8	15	8
August	68	38	52.2	1.63	2	5	24	18

Meteorological observations—Continued.

ST. MICHAEL. Rev. J. Post, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	°*F.*	°*F.*	°*F.*	*Inches.*				
October	42	13	32.2	0.04	3	13	15	2
November	31	1	17.4	.80	4	8	18	5
December	35	−36	4.4	0	7	7	17	0
1900.								
January	30	−38	− 6.1	.40	18	4	9	2
February	38	−13	16	1	13	5	10	1
March	40	−18	10.4	1	15	3	13	1
April	44	−26	17.6	.40	9	2	19	2
May	54	17	34.7	0	8	6	17	0
June	64	31	44.2	0	10	3	17	0
July	77	40	55.6	([a])	5	5	21	....
August	65	37	50.2	([a])	2	2	27	....
September	56	25	43.6	([a])	....	....	30	....
October	53	0	30.4	([a])	3	2	26	....
November	43	− 9	21	([a])	9	2	19	....
December	33	−12	11	([a])	8	3	20	....
1901.								
January	37	−30	− 5.4	([a])	18	1	12	....
February	38	−27	7	([a])	15	1	12	....
March	24	−16	3.5	([a])	15	2	14	....
April	37	−15	11.8	([a])	15	3	12	....
May	43	− 3	25.2	([a])	13	1	17	....
June	61	23	40.8	([a])	3	1	26	....

NOME. N. A. T. & T. Co., Observer.

August (19 days)	59	28	45.4	0.60	9	10	0	3
September	54	22	39	7	11	4	15	17

KOTZEBUE SOUND. Anna M. Foster, Observer.

1898.								
June	72	27	48	([a])	20	([a])	10	([a])
July	81	82	55	([a])	14	([a])	17	([a])
August	64	38	50	([a])	8	([a])	23	([a])
September	50	25	39.4	([a])	12	([a])	13	([a])
October	43	− 5	24.3	([a])	18	([a])	13	([a])
November	19	−23	0	([a])	17	([a])	13	([a])
December	27	−39	7.2	([a])	13	([a])	18	([a])
1899.								
January	17	−31	−10	([a])	17	([a])	14	([a])
February	23	−38	− 9	([a])	20	([a])	8	([a])
March	32	−36	1	([a])	15	([a])	16	([a])
April	40	−24	12	([a])	16	([a])	14	([a])
May	59	− 4	29.3	([a])	13	([a])	17	([a])
June	53	27	37.4	([a])	14	([a])	16	([a])
July	67	34	49.4	([a])	13	([a])	18	([a])
August	63	18	38.6	([a])	16	([a])	15	([a])
September	63	18	38.6	([a])	16	([a])	15	([a])
October	37	− 2	22	([a])	8	([a])	23	([a])
November	22	−17	7	([a])	15	([a])	15	([a])
December	22	−35	− 9	([a])	13	([a])	18	([a])

KOTZEBUE SOUND. Robert Samms, Observer.

1900.								
January	21	−43	−17.1	([a])	20	([a])	11	([a])
February	29	−25	3.3	([a])	19	([a])	9	([a])
March	39	−27	1.2	([a])	20	([a])	11	([a])
April	39	−27	7.6	([a])	17	([a])	13	([a])
May	44	2	28.7	([a])	25	([a])	6	([a])
June	65	27	39.2	([a])	16	([a])	14	([a])
July	71	35	53	([a])	23	([a])	8	([a])

[a] Not reported.

Meteorological observations—Continued.

KOTZEBUE SOUND. Robert Samms, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°*F.*	°*F.*	°*F.*	*Inches.*				
August	66	31	48.8	([a])	15	....	16	....
September	52	27	39.1	([a])	6	....	24	....
October	45	−14	22.7	([a])	10	....	21	....
November	38	−20	9	([a])	15	....	15	....
December	20	−26	2	([a])	8	....	23	....
1901.								
January	33	−50	−24.8	([a])	11	....	20	....
February	34	−45	− 6.5	([a])	14	....	14	....
March	22	−27	− .5	([a])	28	....	3	1
April	35	−20	8.3	([a])	20	....	10	....
May	48	....	22.6	([a])	19	....	12	....

EAGLE. U. G. Myers, Section Director.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
August (16 days)	76	24	50.1	1.63	2	5	9	8
September	66	8	41	.80	3	7	20	7
October	41	−19	21	.65	4	9	18	7
November	33	−25	1.2	.52	2	4	24	5
December	31	−57	−19	.26	15	3	13	6
1900.								
January	23	−68	−24.8	.52	14	6	11	7
February	18	−51	− 6	.39	11	9	9	5
March	56	−46	13	.02	17	8	6	2
April	54	−12	29.3	.42	6	13	11	6
May	69	20	42.2	.84	9	17	5	7
June	87	28	52.6	1.57	8	7	15	13
July	81	31	56.9	1.88	12	9	10	13
August	79	25	49.1	2.71	2	9	20	16
September	68	15	40.4	1.72	4	6	20	14
October	44	−17	20.1	1.23	5	10	16	10
November	18	−42	−10	.21	9	8	13	5
December	32	−52	− 7.4	.77	9	6	16	8
1901.								
January	32	−68	−17.8	.42	13	8	10	8
February	28	−65	−15.3	.55	15	6	7	4
March	42	−49	5	.55	9	8	14	9
April	53	−26	19	.56	8	12	10	6
May	71	16	39.1	1.63	11	8	12	9
June	34	27	52.8	1.22	3	13	14	11
July	85	36	57.6	1.47	9	9	13	12

FORT YUKON. L. J. H. Wooden, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
September	54	9	34.3	0.10	....	....	....	....
October	40	−13	18.7	.45	4	15	12	6
November	23	−34	− 1.4	.30	8	12	10	3
December	16	−68	−16.1	.47	4	10	17	5
1900.								
January	....	−62	....	.36	19	5	7	7
February	....	−44	....	.00	20	8	0	0
March	....	−42	....	.42	14	10	7	5
April	....	−21	....	.05	15	9	6	3
May	....	....	....	....	....	....	....	....
June	93	27	58.6	1.19	6	21	3	9
July	87	41	64.2	.32	13	15	3	3
August	80	23	53.6	1.32	5	9	16	11
September	70	19	42.6	.45	5	4	19	8
October	48	−17	16.9	.59	5	11	15	11
November	22	−43	−10.8	.51	8	13	9	6
December	8	−56	−26	.24	5	9	17	5

[a] Not reported.

Meteorological observations—Continued.

FORT YUKON. L. J. H. Wooden, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.	°F.	°F.	°F.	Inches.				
January	....	−65	....	0.55	12	5	13	8
February	....	−53	....	.03	15	9	4	2
March	25	−41	1.6	.38	9	17	5	8
April	51	−16	17.4	.56	16	14	....	5
May	66	8	33.2	.46	17	13	1	6
June	85	26	58.6	.41	12	18	....	4

RAMPART. Alvin Liebes, Observer.

1900.								
September (last 6 days)	49	22	41.2	([a])	1	....	5	1
October (23 days)	45	−12	22.7	([a])	2	3	18	....
November	28	−52	− 5.8	([a])	....	....	....	....
December	30	−53	−11.2	([a])	....	....	....	....
1901.								
January	19	−61	−23.4	([a])	....	....	....	....
February	41	−48	−10.3	([b])	....	....	....	....

HOLY CROSS MISSION. Rev. R. J. Crimont, Observer.

1898.								
November	32	−23	1.9	2.48	9	10	11	13
December	30	−37	3.4	....	9	15	7	5
1899.								
January	35	−40	− 3.2	5.10	15	6	10	3
February	39	−37	− 3.1	1.46	18	5	5	0
March	45	16	15.6	1.49	14	9	8	6
April	46	0	27.3	1.42	13	9	8	9
May	57	13	39.4	.30	18	12	11	8
June	74	24	50.6	....	11	12	7	....
July	82	31	56.9	....	8	6	17	....
August	70	31	51.5	3.67	0	12	19	14
September	62	17	40.9	4.40	2	15	13	19
October	44	16	30.3	1.17	4	12	15	15
November	23	− 5	10.6	.49	10	18	2	8
December	34	−40	− 2.2	.82	16	7	8	9
1900.								
January	35	−55	− 9.6	.74	23	4	4	7
February	39	−15	14.7	.57	12	8	8	8
March	44	−13	15.5	.50	22	4	5	5
April	48	−21	24.7	.46	5	15	10	6
May	63	18	42.5	.92	5	18	8	11
June	74	29	52.4	1.67	16	7	7	7
July	77	41	58.8	1.44	12	10	9	15
August	64	35	52	5.74	2	10	19	29
September	57	25	44.1	6.69	3	15	12	20
October	57	−14	27.8	3.34	4	11	16	18
November	41	−19	14.4	1.98	12	6	12	7
December	35	−24	5.8	4.49	10	9	12	16
1901.								
January	30	−45	−11.4	1.46	14	4	13	9
February	41	−32	8.3	2.46	9	9	10	11
March	37	−28	10	1.06	5	20	6	10
April	46	−13	20.6	.55	14	8	8	6
May	57	8	35.2	.13	16	12	3	3
June	70	29	51.9	.85	7	13	10	10

[a] Not reported.
[b] Rain from evening of 4th to evening of 7th.

ANNUAL REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION FOR 1901.

By Jared G. Smith, *Special Agent in Charge.*

INTRODUCTION.

The establishment of the present agricultural experiment station in the Hawaiian Islands had its inception in the appropriation made by the Fifty-sixth Congress, first session, when the sum of $10,000 was granted to enable the Secretary of Agriculture to investigate the field and establish an experiment station in Hawaii as has been done elsewhere. In pursuance of the act of Congress, Dr. W. C. Stubbs, director of the Louisiana Agricultural Experiment Stations, was sent to Hawaii during the summer of 1900, and the results of his inquiry are given in a report transmitted to Congress in January, 1901, and published as House Doc. 368 (Fifty-sixth Congress, second session), and afterwards as Bulletin 95 of the Office of Experiment Stations of the U. S. Department of Agriculture. Dr. Stubbs was instructed to investigate the agricultural conditions of the islands, with special reference to the organization and work of an experiment station. It was recommended by him that the station to be established should be under the control of the Secretary of Agriculture and independent of local institutions. A station for the study of all matters pertaining to the sugar industry has been maintained for a number of years by the Hawaiian Sugar Planters' Association, and as it will continue to prosecute its work upon problems relating to the sugar industry it was believed best that the station to be established under the auspices of the Department of Agriculture should devote its energies chiefly to other agricultural interests. Among the subjects to which it was suggested the station should give its attention are the culture of fruits, vegetables, rice, forage crops, coffee growing, stock raising, dairying, irrigation, and forestry.

After conferring with the local authorities, the tract known as Kewalo-uka, adjoining the city of Honolulu, was recommended as a site for the station. (Pl. XXV.) This tract had been set aside by former officials for experimental investigations in agriculture and forestry. An examination of the records of the former Hawaiian Government showed that while there was a very evident intention to reserve this land for experimental purposes, the necessary formalities were

never fully carried out. Subsequently 20 acres was reserved by Presidential proclamation as a site for a hospital for the Navy Department, and 7 acres for the same purpose for the Marine-Hospital Service under the Treasury Department.

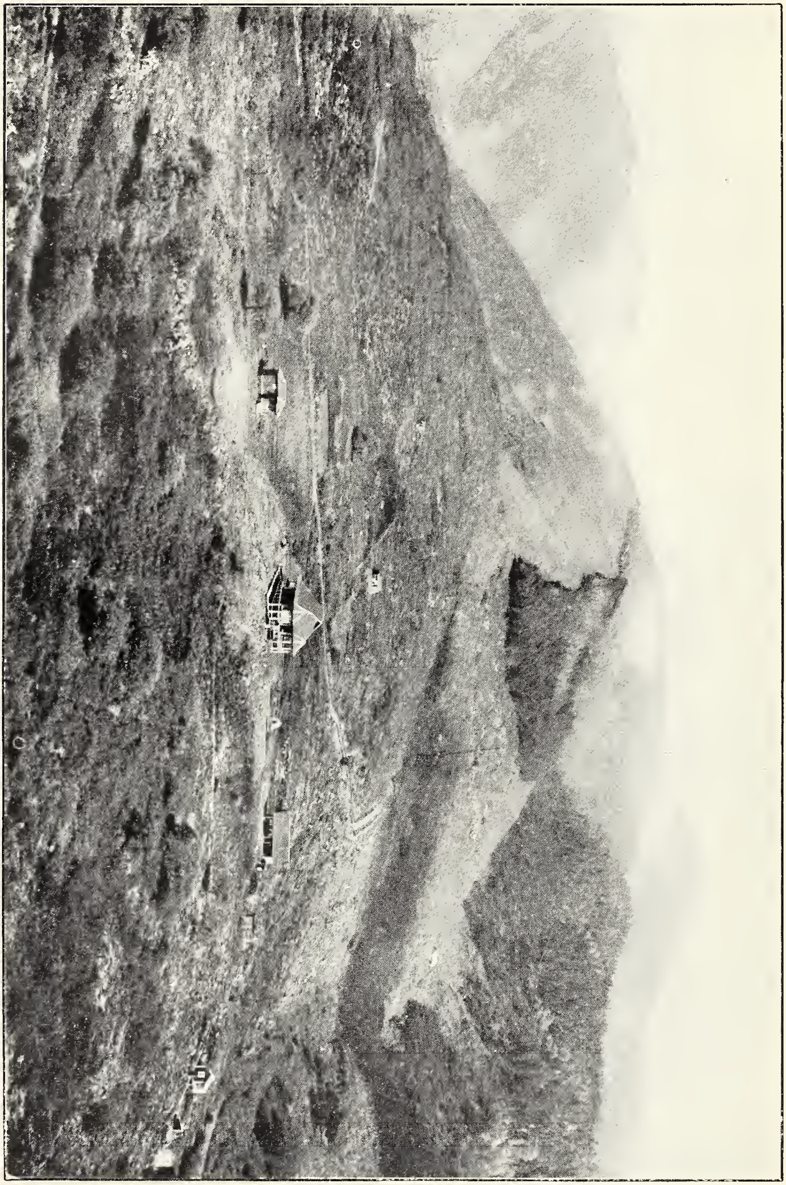
Acting upon the suggestions made in the preliminary report, Congress appropriated $12,000 for continuing the work during the current fiscal year, and immediate measures were taken to establish and equip a station in accordance with the above recommendations. Accordingly the writer was transferred to the Office of Experiment Stations from the Section of Seed and Plant Introduction of the Department of Agriculture, and was charged with the responsibility of beginning the work of organization of the Hawaii Agricultural Experiment Station. In carrying out my instructions I left Washington, D. C., March 21, 1901, arriving in Honolulu on April 5, and at once began active operations to carry out the desires of the honorable Secretary of Agriculture as I understood them.

A temporary office was secured in the Territorial capital building and was fitted up with desks, office furniture, bookcases, etc.

DETAILED REPORT OF WORK.

The period from April 5 to May 15 was occupied in making preliminary surveys of the land which had been set apart for the use of the station, the Kewalo-uka tract in Makiki Valley, adjacent to the city of Honolulu. This tract, containing 154 acres, lying along the southeast slope of the Punchbowl and Tantalus ridge, is nearly 2 miles long and has a maximum width of about 300 yards at its lowest portion, nearest the city, and about 100 yards at the upper end. The elevation ranges from 125 feet, nearest the city, to 1,350 feet on the end nearest Mount Tantalus, the height of that peak being 2,013 feet.

Although the preliminary arrangements had been entered into in September, 1900, between the governor of the Territory and Dr. Stubbs, yet the formal transfer did not take place until June 10, 1901, when two tracts were reserved to the Territory, one of 10 acres as a stone quarry and a second of 52 acres on the slopes and within the crater of Punchbowl Hill, which was reserved for a public park. By the courtesy of the Secretary of the Navy this Department was granted the temporary use of the naval hospital site for experimental purposes. The work of clearing land and erecting buildings was begun with as little delay as possible. Twenty-four acres, comprising all of the Naval Hospital Reservation and land adjacent to it, was cleared of a dense growth of guava and lantana bushes, prickly pear, and algaroba or mesquite bean woods. (Pl. XXVI, fig. 1.) The contract under which the work was performed called for the removal of all tree stumps and roots and plowing the land to the depth of 20 inches. This work was



HAWAII STATION SITE.

FIG. 1.—HAWAII STATION—VIEW OF STATION SITE BEFORE BEGINNING CLEARING.

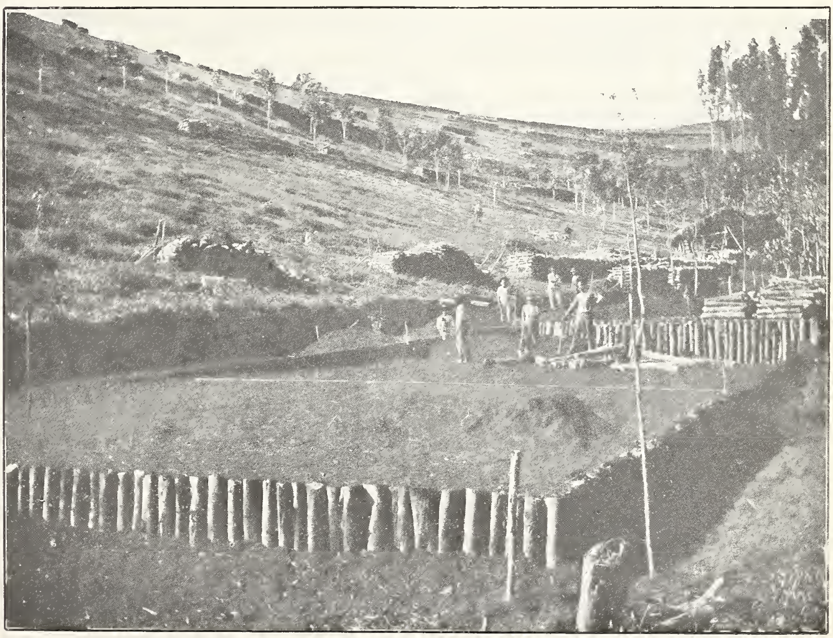


FIG. 2.—HAWAII STATION—BUILDING TERRACES ON UPPER PART OF STATION FARM.

FIG. 1.—HAWAII STATION—DIRECTOR'S RESIDENCE.

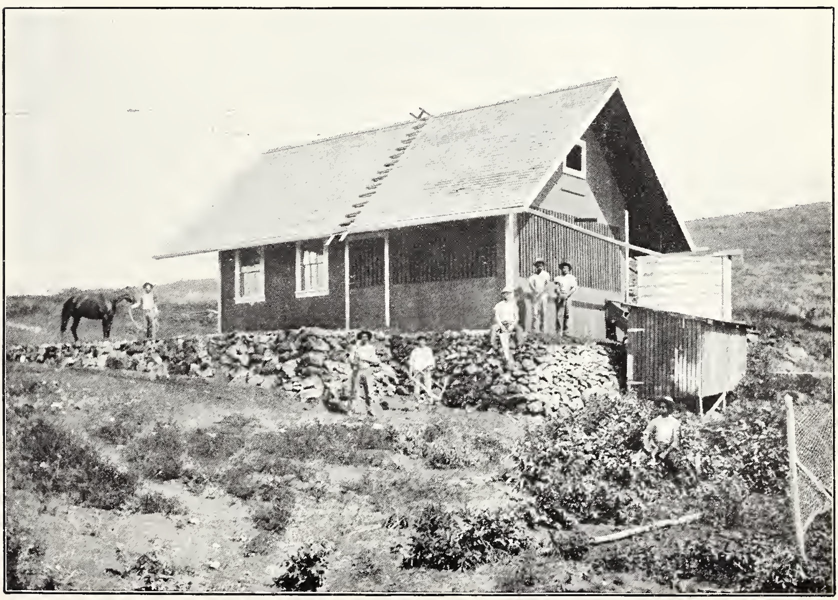


FIG. 2.—HAWAII STATION—STABLE.

not completed within the period agreed upon, but was carried out in an extremely careful manner, reflecting great credit upon the contractor. The cost of this work amounted to $30 per acre. About 30 cords of wood, worth $10 a cord, were obtained from this land and are now on hand subject to sale.

Thirteen acres of 15-year-old planted eucalyptus or Australian gum forest was also cleared at the upper end of the tract at a contract price of $65 per acre. (Pl. XXVI, fig 2). The trees were very dense in this forest, and the cost of removal of roots and stumps much greater than in the open algaroba and guava woods at the lower elevation. This contract was carried out by Japanese labor and was not as efficiently performed as the previous one, given to an American firm. About 400 cords of wood were secured by the station, valued at $3 to $3.50 per cord.

Contracts were also let for the erection of an office and a residence building. The office contains two rooms, and is intended to be only one wing of a building, the remainder to be completed at a later date.

The residence contains six rooms. Both office and residence occupy a commanding position on the heights above and back of Honolulu, at an elevation of 350 feet above sea level. These buildings cost $3,900, the contract not including the painting. (Pl. XXVII, fig. 1.)

A 2-story stable, 18 by 32 feet, with three stalls, carriage room, tool and harness rooms, was planned and built by the special agent in charge. In connection with the stable are a 2,000-gallon tank, watering trough, and manure shed, and there are feed bins and chutes at convenient location. (Pl. XXVII, fig. 2.)

A 2-room hut or cottage was also built to serve as quarters for the laborers employed. A poultry house and poultry yard inclosed by wire netting has been built; also a small house in which to store dynamite, considerable amounts of which have been used in blasting and grading operations necessary in grading and making roads around the station buildings.

A seed bed was prepared and covered over with slats in lieu of a glass or canvas covered propagating house.

The location of the station buildings having been made above the level to which city water is at present supplied, a water system had to be installed by the station. A line of 1-inch pipe was laid 900 feet to connect with the city water system, and a 10,000-gallon tank was placed at an elevation of 250 feet, that being the maximum height above sea level at which city water is now supplied. Another 10,000-gallon tank was erected back of the residence, at a height above the floor line to give enough water pressure in both office and residence.

A 1½-horsepower gasoline engine and double-acting pump were installed at the 260-foot level, and the water is pumped through a 2-inch galvanized iron pipe into the upper tank. A 4-inch swing check

valve was placed between the pump and the upper tank to relieve the engine from the longitudinal vibration resulting from the alternating rise and fall of the 2-inch column of water in the discharge pipe. The working pressure is about 47 pounds. All outside water connections, including the installation of the pumping plant, were made by station employees and not by contract; this having proved the only satisfactory way of getting work done, and at the same time the cheapest.

A dark room for photographic work and the storage of chemicals has been built in one of the office rooms, and a water-closet is also being added. About 200 feet of board walks have been laid. All station buildings have been painted at least one coat by workmen employed direct by the station, this having been found to be the cheapest and most satisfactory method for all work. A garden has been prepared by trenching the soil and adding lime. About 20 acres on the slope above the station buildings had been roughly cleared of guava and lantana to allow the grass to grow up for pasturage. Tools required for the large force of laborers employed have been purchased from time to time, so that there is now on hand a very satisfactory supply, including the ordinary farm, blacksmith, and carpenter's articles. A blacksmith shop is planned and will shortly be erected, so that repairs and breakages may be attended to without delay and at little cost.

A fire plug with 50 feet of fire hose has been connected with the main discharge pipe from the pump to give needed fire protection. Other connections will be installed at each of the principal buildings. The large tank has been connected with the one beside the stable, and this in turn with a smaller one at the laborers' quarters, and connections have been made where easy of access in the garden for irrigation, on a moderate scale.

On the upper clearing where the blue-gum forest was cut away, about 1½ acres have been dug over and terraced, using some of the cord wood for buttress work. Here also a two-room hut has been erected for laborers' quarters, at an elevation of about 1,075 feet. This cottage has a corrugated galvanized-iron roof, made with a 4-foot overhang, the idea being to collect as much rainfall as possible. Besides the two living rooms there is a large supply and tool room. The water from the room is stored in a 3,000-gallon tank; pipes are laid from this so that the water can be used on the terraces. A 2,000-gallon tank and lumber for the construction of a small stable are now on the ground and will be put up some time this winter. These buildings were considered necessary because of the elevation above the main station buildings. The upper clearing is more than a mile from the office by the most direct route, along a narrow and steep bridle trail, or fully 4 miles by the winding Tantalus wagon road.

This comprises in brief the constructive work on the Hawaii Experi-

ment Station for the period from April 5 to November 1, 1901, seven months.

The correspondence has been rather large, the station having already given assistance and information to many farmers in all the islands of the group.

Some poultry experiments have also been inaugurated. These could be undertaken immediately without great expense, and it is hoped that they may lead to results of immediate practical usefulness. Largely because of the great number of diseases with which barnyard fowls are afflicted in the Hawaiian Islands the supply of poultry does not meet the demand. Live chickens sell in Honolulu markets for $15 a dozen and eggs at from 40 to 50 cents a dozen. If the station can demonstrate a practical way for the economical production of chickens and eggs it will add largely to the resources of the small farmers on the islands. The ravages of the disease known as sore head are so severe as to almost prevent the raising of domestic fowls. An article on Chickens and their diseases in Hawaii has been prepared by my assistant, Mr. T. F. Sedgwick, and published as Bulletin No. 1 of the Hawaii Station. This treats of sore head, as well as of several other common diseases, and gives simple precautions and preventive measures which, if adopted by poultry growers, will do much toward enabling farmers to fight disease.

As soon as possible, experiments will be begun in animal husbandry and dairying. Owing largely to an insufficiency of forage, meats are very expensive. In the markets of Honolulu hogs sell for from 10 to 17 cents per pound live weight. To remedy this difficulty it is intended to undertake at an early day feeding experiments with various roots and tubers and with the common papaya as food for swine.

As soon as possible, experiments in dairying should be undertaken upon a carefully planned system. Dairying and cattle feeding are now being carried on on a small scale with some measure of success, but the supply of milk and butter is insufficient to meet the demands of the home trade. Island butter retails for 60 cents per pound, milk for 12 cents a quart, and Hawaiian-made cheese is almost unknown in the Hawaiian markets. A few of the dairies are managed on a scientific basis.

There is, moreover, widespread ignorance of the best combinations of feeds and too great dependence on one-sided rations both in feeding dairy cattle and in fattening animals for the shambles. The use and necessity of leguminous forage plants are not recognized. Enough by-products of the sugar plantations are burned every year to feed all the beef, pork, and mutton consumed in the islands.

Experiments should be conducted in the utilization of the waste cane tops in the form of silage for feeding dairy cattle and beef steers, and with the waste molasses for fattening sheep, cattle, and hogs. On

some plantations the work horses and mules are fed cane tops and molasses to good advantage. The practice can be extended to other branches of animal husbandry with profit. But it is of even greater importance that extensive experiments be carried on with forage plants rich in protein, the clovers and beans, to supplement and fully utilize the heat and fat-making constituents of the cane top and sorghum rations generally used. The Hawaiian Islands can grow and fatten more than enough animals to supply the home demand. At present, considerable importations of cattle, beef, mutton, hogs, and pork are made from the mainland, Australia, and New Zealand. Because of the location of the group, Hawaii ought to be able to command a superior market for all her surplus dairy and meat products in the Orient.

HORTICULTURAL INVESTIGATIONS.

Plans are being made for experiments in horticulture, including both fruits and vegetables, and coffee culture. These will include experiments with reference to the methods and times of pruning, methods of cultivation, picking, and marketing, as well as tests of varieties.

The Hawaiian Islands market depends largely on supplies of fruits from the mainland at all seasons of the year. Not only can enough fruit in sufficient variety be grown to supply the local markets, but both fruit and vegetables might be grown for export. The Honolulu market is usually well supplied with fruits and vegetables, though not always of the best quality nor in large variety, but the plantations, farms, and ranches depend largely on canned products. Work to show the practicability of the growing of a wide range of fruits and vegetables for the home table at a distance from well filled markets will be profitable and desirable.

It is hoped that experiments in coffee culture and the growing of various spices and drugs may also be undertaken at an early day.

COFFEE IN HAWAII.

Probably $10,000,000 has been sunk in unprofitable coffee cultivation in these islands during the last ten years. An intelligent investigation of all phases of the coffee industry will well repay. Coffee is a white man's crop. It is grown at elevations unsuited to cane and where the climate is admirably adapted to a comfortable and healthful existence.

The coffee lands of Hawaii can be made as productive as any in the world. Experiments in the selection and crossing of varieties to produce more prolific or hardier trees, and especially an investigation of the methods of curing coffee, should be made in an effort to save this industry. Hawaiian coffee has already made for itself an enviable

reputation for quality and flavor of berry. If it could be sold on its merits instead of in competition with the low-grade coffees of Brazil and Central America, it would in time prove an immensely profitable crop. An effort should be made to save this industry from total extinction. It is a crop especially suited to the small farmer and the small investor—the man who can build up a home and care for his crop himself. The establishment of the coffee industry on a successful basis would make the Hawaiian Islands a land of small farmers more quickly than the transformation could be accomplished in any other way or through the medium of any other crop or industry.

The exports of coffee from the Territory of Hawaii during the fiscal year ended June 30, 1901, amounted to upward of 2,600,000 pounds, valued at $311,000. The production of 1901 has been greater than that for any preceding year. This increase in yield and amount exported is in spite of unprecedentedly low prices for coffee and a general overstocking of the markets of the world. The downward trend of the prices of all grades of coffee since 1895 has brought ruin to hundreds of small planters in the Hawaiian Islands. Only those continue in the industry who have sufficient capital to tide over years of depression, or who are content to market their product at or below the bare cost of production. Those of the former class are very few in number; those of the latter comprise the hundreds of Portuguese, Hawaiian, and Japanese landowners, homesteaders, and renters having 5, 10, 20, or sometimes 40 acres of bearing trees. In most of the coffee districts on the islands the owners of the larger tracts of bearing coffee have ceased to cultivate their plantations and are spending no money on the harvesting of the crop, allowing the berries to dry on the trees or rot on the ground, unless they are able to make contracts with Japanese or Portuguese to harvest the crop on shares, and in that case are content with one-fifth to one-half of the crop, the Japanese or Portuguese laborer receiving the balance in payment for his services.

The islands on which there are now bearing plantations of coffee are, in the order of their importance, Hawaii, Maui, Kauai, and Oahu.

On Hawaii, where the largest areas are planted, the chief producing districts are, in the order of their importance, Kona, Olaa, and Hamakua, while Kau, Hilo, Puna, and Waimea add their quota to the whole.

A preliminary survey has been made of the Hamakua, Olaa, and Puna districts of Hawaii, all lying on the windward, or west coast of the island. Even a most hurried glance at these few districts can not fail to impress upon the visitor the fact that the island of Hawaii is the home of coffee. Whether the plant is given the most scientific and careful cultivation, or through stress of circumstances the plantation has become overgrown with fern and weed and is totally uncared for, the trees throughout show a thrift and a freedom from disease which

augurs well for the success of this crop whenever market conditions or a rise in prices again permit the rehabilitation of the industry. Even under the most adverse conditions of shallow, sterile soils, excessive rainfall, and acid or poisonous subsoils the yield per tree and per acre is often surprisingly large. On the Horner plantation, Kukaiau, 400 trees yielded 1,500 pounds of coffee at their first crop. On both the Horner and Louisson plantations in Hamakua, individual trees have yielded from 5 to 7 pounds of coffee—not simply selected trees at wide intervals, but whole fields. As judged by results in pounds of coffee per acre, the Hamakua district is absolutely ideal for this crop, and this district alone can challenge the world with the quality of its product. The berries are borne (on the Guatemalan variety) from 20 to 30 in a cluster, and the clusters are so thick along the branches that one wonders how any more berries could possibly be borne on any part of the plant, unless they were underground on the root. (Pl. XXVIII, fig. 1.)

The coffee lands of Hamakua overlap the cane lands. Mr. J. M. Horner, the pioneer in this industry, states that the area suited to coffee in Hamakua comprises a belt 35 miles long and 3 miles wide, and from 500 to 3,000 feet elevation. It reaches from about 2 miles on the Hilo side of the Maulua gulch to the Kohala plain. The bulk of this 67,200 acres is still government land, and if such conditions should arise as would permit an extension of the coffee industry in Hawaii nearly all of this area could be utilized. At a fair average yield of one-half ton per acre, the arable portion of this stretch of fertile forest land could be made to produce from 25,000,000 to 30,000,000 pounds of coffee per annum. Hamakua coffee was awarded the highest premium at the Omaha Exposition, in competition with coffee from all over the world—from Java, Brazil, Central America, Arabia, and various South American countries.

The typical Hamakua coffee soil is a mellow forest loam, deep and well drained yet retentive of moisture, easily worked, and quickly responding to fertilization and good cultivation. The district is distinguished from those bordering it by an absence of running streams. The abundant rainfall (about 100 inches per annum) sinks into the porous soil and is readily conserved by deep tillage. It was a matter of comment that the crops grown on these typical coffee soils exhibited a remarkable resistance to drought during the dry season of 1901.

At the time of the height of the coffee industry in Hawaii, in 1897, 1898, and 1899, upward of 6,000 acres were planted to this crop in the Olaa district. There were about 1,500 families of small settlers and homsteaders in the Puna, Hilo and Olaa districts, all more or less dependent on the future of coffee. Now, December, 1901, there are not to exceed 250 families. Of the 200 white settlers in Olaa alone, only some 25 now remain, and most of these depend on other money crops

FIG. 1.—HAWAII STATION—THREE-YEAR-OLD HORNER'S GUATEMALA COFFEE.

FIG. 2.—HAWAII STATION—JAPANESE PICKING COFFEE.

than coffee. A typical 100-acre farm formerly in coffee now consists of 20 acres cane, 15 coffee, 15 orange, 2 lemon, 4 bananas, 1 pineapples, 1 bamboo, 4 forage crops, 2 pasture, 6 experimental garden, 4 prepared for planting bananas, and the balance forest and the lands surrounding the home buildings. Most of the Olaa and almost all of the Hilo and Puna coffee orchards have been pulled up and cane planted in their stead, or have been simply deserted by their owners. Deserted homes characterize the formerly prosperous Olaa colony. The loss of capital in this one district amounts to over $2,000,000 in the last five years.

The cause of the failure of the coffee industry in Hawaii has been primarily the abnormally low prices of coffee, due to overproduction in coffee-growing countries all over the world. Annexation made the sugar planters wealthy because Hawaiian sugar was at once admitted duty free. It also brought ruin to the coffee planters because it placed Hawaiian coffee in competition with the South and Central American duty-free coffee, whereas there had been up to the time of annexation a duty on foreign coffees imported into Hawaii. It reaches its optimum development at elevations of from 1,300 to 2,500 feet above sea level, and in this Territory that belt is, on all the islands, one where the climatic conditions are ideal. If coffee can be restored by Congress to the same status which it enjoyed previous to American control, Hawaii and Porto Rico can produce within ten years all of the amount consumed by the United States. A duty of from 2½ to 5 cents per pound on coffee would do more toward making Hawaii a land of prosperous homesteads and prosperous people than any other legislative measure which could be taken. The coffee lands lie above the cane lands and the development of the coffee industry will thus not interfere with cane growing. But in case sugar should even go down to such a point that its cultivation would prove unprofitable, at least a portion of the cane lands in some portions of the islands would be capable of profitable conversion into coffee. There has been enough experience in coffee growing in these islands to develop a distinctly Hawaiian system of cultivation and treatment. The mistakes made by new men in a new land with a new and untried crop, such, for instance, as that of using Ceylon methods in Olaa, have been costly, but such work will not have to be done over again. There are still many men who believe in the future of coffee in Hawaii. These are maintaining their plantations at least possible cost, but with a view to deriving at least a living from the land. The low prices for the crop have weeded out all except these who were conducting the business on an economical basis.

There are, at a low estimate, 200,000 acres of coffee lands on the four islands, Oahu, Maui, Kauai, and Hawaii, most of it still virgin forest. And there is another 100,000 acres and more which would not fall within the belt of optimum conditions, but where coffee could

undoubtedly be grown. The limit of production would be near 100,000 tons, and this yield could be reached without converting to the purpose one single acre of land on which sugar cane is now grown. If Congress will afford to coffee the same protection which is extended to sugar, it would mean not only the building up of an industry among our own people and within our own borders, but the establishment of this industry on a firm basis would also mean a marked increase in the number of small landowners. From the national standpoint, that State which produces or can produce within its own borders the greatest number of necessaries consumed by its own people is the strongest. To foster the coffee industry in these islands of the Pacific will be to make Hawaii a stronger member of the family of States.

I append herewith some correspondence which may throw more light on the subject. I believe from what I know of the islands that Mr. Wight's views are correct and unprejudiced. They are certainly worthy of consideration.

Honolulu, H. I., *May 16, 1901.*

Dear Sir: In conversation with Mr. A. Louisson he stated that you were desirous of obtaining authentic information in regard to the cultivation of coffee and other crops adapted to these latitudes, and, having gone into this matter most thoroughly, I take pleasure in placing such information as I have at your disposal.

LOCATION AND PREPARATION OF PLANTATIONS.

Experience has demonstrated that coffee can be successfully cultivated only at an elevation of over 1,000 feet, and the best results are obtained at an altitude in the neighborhood of 2,000 feet. A deep rich soil is essential, and also a certain amount of shade. The lands in the Hamakua district above the cane belts from Kukuihaele to Laupahoehoe grow fine coffee; from Laupahoehoe into Hilo results have not been satisfactory. This is probably due to a clayey subsoil. The upper lands in the district of Kona are also suited to the cultivation of coffee. A rainfall of from 50 to 100 inches a year, evenly distributed, is essential to produce the best grades. Absence from wind is also requisite.

The first step in opening a coffee plantation is the erection of laborers' quarters. Fifteen dollars an acre will cover this expense, including suitable water containers. The next step is clearing the land. The best practice is to cut down the forest, cutting the trunks of trees over 1 foot in diameter in lengths of 8 feet, and below 1 foot in diameter in lengths of 12 feet. All brush smaller than one's wrist is best burned, but great care should be taken in burning the brush not to burn over the land. The ferns which are invariably found in forest land keep the ground moist, prevent weeds from growing, and also protect the young coffee trees against insects, and the growth of the ferns does not interfere with the growth of the coffee.

There is no doubt but that coffee grows better in the shade than in the open, the amount of shade depending on the rainfall and altitude of the plantation. In the Hamakua district 12 shade trees to the acre give the best results. Coffee trees grown in the open throw out branches close together, necessitating much extra labor for pruning; those grown in too dense shade throw out branches too far apart and the crop does not ripen well, but by placing shade trees judiciously the coffee grows sufficiently open to make the labor of pruning nominal.

PREPARING LAND FOR PLANTING.

After a forest is felled and cut into lengths, the timber should be placed in rows from 8 to 10 feet apart; holes to be dug in the space thus cleared for the young coffee trees. The best distance to space the rows is still a matter of discussion. Eight or nine feet is the most common practice.

PLANTING AND CULTIVATION.

This is a most important process, and should be done only by men who have been carefully taught this work. A peculiarity of the coffee tree is that if the taproot be not planted straight the tree will not flourish, and replanting is inevitable.

VARIETIES.

The best results have been obtained from seed known as Horner Guatemala. The origin of this seed is obscure. The variety is identical with the best grade of Java coffee. I have imported the best varieties of Java, but the Horner seed produces a coffee in every way equal to the Java in appearance, while the flavor is superior. Both the Java and the Horner coffees give trees which send out branches straight from the trunk. The Hawaiian coffee droops, and in consequence pruning and picking from the Hawaiian trees are more expensive. The quality is also inferior to either of the above varieties.

In planting coffee a great many "sports" are found, and there is no doubt that, under judicious experimental cultivation improved varieties would be discovered.

After the plantation is started, the care required for the first year is very slight. In the Hamakua district, in forest land, one man can easily look after 15 acres, the work consisting in weeding and replanting. Ten per cent is a fair estimate for replanting.

Estimates as to what cultivation ought to cost are of very little value. With the most careful management, and without making any mistakes, it costs $200 to clear an acre of land and maintain it until the trees are four years old, when the first crop is taken off.

COST OF PICKING AND MAINTENANCE.

Having never cultivated coffee over four years old, the cost of keeping up a plantation after this time is unknown to me, but it should not exceed $3 per acre per month exclusive of picking and interest on the investment.

The cost of picking, I know from experience, will amount to between 5 and 10 cents per pound of market coffee, 7½ cents per pound being a fair average. (Pl. XXVIII, fig. 2.)

Cleaning, drying, and transportation will amount to about 3 cents per pound more. In other words, figuring an acre of coffee ready to bear at $200, it costs 12 cents to produce 1 pound of marketable coffee laid down in Honolulu.

Our coffee is divided into several grades. The best brings about 13 cents; the poorer grades, about 9 cents per pound, the above figures representing a crop whose average value is 12 cents per pound. In the figures given as to the cost of bringing an acre of coffee into bearing the cost of superintendence has not been taken into consideration. A man cultivating his own crop would make this item nominal, whereas an expensive manager on a small plantation would make this cost greater than all others. On a well-managed plantation of 100 acres, a fair estimate for the manager's time, and the cost of a residence, would increase the price per acre $100, making the total cost of 4-year-old coffee $300 per acre.

Rainfall has a very decided bearing on the selling price of coffee. Where the rainfall is regular throughout the year a large berry of regular shape is produced; where the rainfall is spasmodic the berry is small and irregular in shape. A large regular-

shaped berry will bring from 1 to 2 cents per pound more than a small misshaped berry, although the cup qualties of the coffees are precisely the same.

The selection of a location for a coffee plantation is a most important consideration, and a newcomer should under no circumstances decide this matter without the advice of a successful cultivator.

Being thoroughly familiar with the island of Hawaii from Kohala to Kau, I can say the land of Hamakua, immediately back of the Hamakua and Paauhau sugar plantations, lying at an elevation of from 1,500 to 3,000 feet, offers the best natural advantages of any district; and should you contemplate establishing an experimental station for the cultivation of coffee, I would suggest that you select a location in the Hamakua district.

PRESENT STATUS OF THE INDUSTRY.

With the most favorable locations and with the best management, coffee can not be produced for less than 12 cents for the average value of entire crop laid down in Honolulu, and this grade will bring an average of 13 cents in San Francisco. Inasmuch as coffee is sold on sixty days' credit, and from three to four months are consumed in selling a crop, the present San Francisco price is barely equal to the cost of production, and unless the industry is encouraged by a protective tariff in the immediate future the entire business so far as the production of the better grades is concerned will be stamped out.

Considerable areas throughout the islands of uncultivated coffee will be picked in a desultory way by Japanese and Hawaiians. The flavor of this grade is very inferior, and the method of curing is crude, and in consequence these coffees are bringing to-day in the San Francisco market from 8 to 10 cents per pound, and a certain irregular production of this grade will be continued under any circumstances.

The cultivation of coffee is one of the most interesting of agricultural pursuits. Mr. J. M. Horner, who is largely engaged in sugar and coffee, once told the writer that when he was thoroughly tired out in the sugar fields, work in the coffee brought back health, strength, and courage.

The altitude at which coffee thrives is best adapted for the production of food crops—corn, potatoes, and garden vegetables can be grown most successfully in connection with coffee, and by the cultivation of forage crops a fine grade of butter and beef can be produced; poultry also flourishes.

The coffee industry of the islands has gone from bad to worse. The situation to-day is such that the market prices of our coffees are below the cost of production, and while a few of the plantations may struggle along for a year or two longer, unless speedy relief be furnished the end is inevitable.

The point where the most favorable location and careful management will enable a coffee plantation to live has been passed, and if you will trouble yourself to inquire at the banks you will find that it is absolutely impossible to obtain a loan on a coffee plantation beyond the bare value of the land, and even then the banks are reluctant to make advances.

Up to the time that we were annexed to the United States the Hawaiian duty on coffee protected our market to the exclusion of all other coffees, but since that time low-grade coffees have been introduced from the United States, and in consequence the Honolulu market has been materially affected. I am not in a position to give statistics, but I believe that at least one-third of the Hawaiian trade in coffee is supplied from abroad, and a representative of a large wholesale house in San Francisco told me that his sales of coffee in these islands were largely increasing.

Referring to your inquiry as to the amount of lands available in the islands for the cultivation of coffee, I am not able to give you any approximately correct information for the reason that certain localities which appear to have every natural advantage will not grow coffee when the actual test is made, and that other localities which

present a very unfavorable appearance give very fine results. But I should estimate that on all of the islands there is in the neighborhood of half a million acres which could be utilized, either wholly in the production of coffee or of coffee in combination with other crops.

J. F. Brown, commissioner of public lands, in 1898 estimated that there were 76,270 acres of Government land suitable for coffee, and there must be at least five times this amount of land held by corporations and individuals. In making this estimate I have taken into consideration only lands above the cane belt—say those lying at altitudes of from 1,000 to 5,000 feet.

Immediate relief to the present situation could be afforded if the United States Government would give our coffees preference in supplying the needs of the Army and Navy, and I would suggest that it might be advisable to bring this fact before the Department of Agriculture at Washington.

MISCELLANEOUS CROPS.

Corn, potatoes, sweet potatoes, cabbage, lettuce, turnips, beets, and Portuguese onions can be fairly successfully cultivated, the one drawback being the cutworm. I have seen a quart of cutworms dug out of a surface 6 feet square, and it is needless to say that under such conditions nothing can be cultivated.

All of our Hawaiian lands produce natural forage crops when the forest is first cleared, viz, honohono (*Opelismenus compositus*) and pualele (*Sonchus oleraceus*), but after the land has been cropped for a certain length of time these plants can not be depended upon, and sorghum, bunch grass, or alfalfa should be planted.

Good dairy stock can be purchased from ranchers, although the price is very high. Cows give as much milk as in California, but it is not as rich nor is the butter as sweet and waxy as that of California. Beef, butter, and hogs command ready sale at high prices at all times, and the possibility of maintaining a dairy exclusively on cultivated forage crops is well worthy of your attention.

Speaking in a general way, after a family has been located six months on a coffee plantation, the living expenses of that family should not exceed $15 per month, provided the cutworm problem can be solved.

The agricultural possibilities of these islands are untried, but the first step in developing the lands of higher altitudes should be the placing of some staple adapted to this section on a firm basis, and this can best be done with coffee. Coffee should become one of the staples of these islands. But unless it be protected to the same extent as rice and sugar, it is folly for anyone to consider the cultivation of this crop.

Neither corn, potatoes, nor garden vegetables can be profitably cultivated to any great extent owing to the lack of a market. The only regular source of demand is the city of Honolulu, and as the white population are the only consumers of European vegetables, this demand is limited; consequently any supply over that required by a population of 10,000 can not be consumed and an extensive production of vegetables is bound to end in failure through lack of a consuming market.

What is known as the Kula district on Maui is used exclusively for the cultivation of corn and potatoes, and although the area cultivated does not exceed 1,000 acres, at times crops have been allowed to rot in the fields owing to the prices having become so low that it did not pay to gather them.

Mr. R. H. Long, who has raised vegetables successfully in Petaluma for the San Francisco market, has undertaken the cultivation of cabbage, tomatoes, cauliflower, celery, beets, turnips, and other garden truck, in the districts of Weimea, Hawaii, and while he has met a number of reverses through cutworms and heavy storms, he is still sanguine as to the ultimate success, but he expects to supply all the markets on these islands from a farm of 100 acres.

In my opinion the fruits of the Temperate Zone can not be profitably cultivated to any extent owing to the small consuming population of the same. A considerable market for oranges ought to be found here and a plantation of 400 or 500 acres should succeed, but I doubt if any considerable foreign market could be found. On the other hand, coffee, gutta-percha, India rubber, cocoa, cacao, cocoanuts, and products which are naturally adapted to this latitude, which will keep indefinitely, and which are used universally all over the world, seem to me more desirable crops.

Yours, very truly, C. S. WIGHT.

Mr. JARED G. SMITH,
Commissioner of the Department of Agriculture,
Honolulu, Island of Oahu, Hawaii Ter.

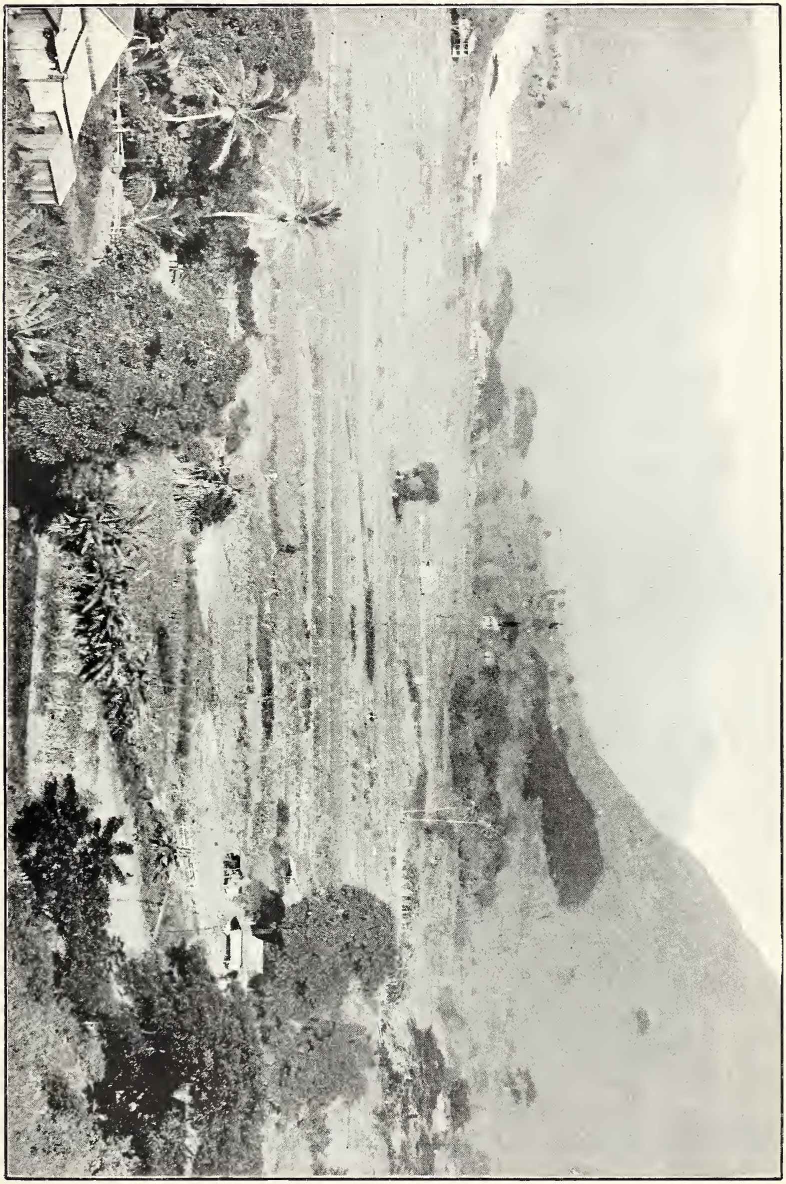
At my request my assistant, Mr. T. F. Sedgwick, has prepared brief statements upon the present condition of a number of important industries, which I submit herewith. It is shown that of such important food crops as potatoes and rice not enough are grown to supply the local demands, and of taro, which is one of the important plants, being used both as bread and as a vegetable, the supply is gradually diminishing, owing to a number of causes.

A cooperative experiment in taro growing was started with Judge Wilcox of Honolulu about August 15. A taro patch was selected in which almost every plant was affected with "blight," and experiments are now being made to find methods by which the disease can be checked. Losses in the yield of taro have in some cases amounted to 90 per cent of the crop. Taro being the staple food of the native Hawaiians, these experiments, if successful, will be of great and immediate practical value. (Pl. XXIX.)

POTATOES.

Formerly potato growing was an important industry, potatoes standing at the head of the list of exports. In 1849 the number of barrels exported was 51,957, but at the present time the local demand is almost wholly supplied by importations, which amount to 1,500,000 to 2,000,000 pounds per annum. The retail price varies from 1½ to 4 cents per pound.

It is estimated that there are at least 6,000 acres of land well adapted to the growing of potatoes. The best potato land is in the Kula district, island of Maui, on the slopes of Haleakala, the yield varying from 1½ to 4 tons per acre. The soil is fine, almost a powder, quite deep, and does not crack. The tubers are smooth and free from pimples and present a good appearance in the market. The size of the potato is inferior, but this is due to poor selection and bad cultivation, as there are records of specimen potatoes 16 inches long and 11 inches in circumference. The quality is excellent, and when properly shipped brings a good price in the market. Good potato land is also found in the vicinity of Kawaihae, island of Hawaii.



HAWAII STATION—RICE AND TARO IN PANOA VALLEY.

Of late years the industry has diminished to a fraction of the home consumption. Most of the potatoes now raised are grown by Japanese, but even they are becoming discouraged owing to the ravages of disease and the use of poor seed. The black rot of the potato has appeared, last year's crop being practically destroyed. This year there are a few struggling patches under the care of Japanese tenants. The cutworm is the chief insect enemy of potato culture.

SWEET POTATOES.

No fair estimate of the present production of the sweet potato has been made, but at one time in the history of the islands it received no little attention, as there are records telling of 50 varieties under cultivation. In 1850 the amount of sweet potatoes exported was 9,631 barrels.

It is a plant easily grown, thriving well on most parts of the islands where the rainfall is not too great. It is often seen growing around native huts in the dry and otherwise barren portions of the country, or over a coral bed where there may be but few inches of soil.

The sweet potato is propagated by cutting off the tops and planting them in a hill of dirt which is often merely the surface soil scraped together.

As an article of food, it is one of the principal vegetables and it is a deplorable fact that at the present time there is so little effort toward home production that large imports are being made, and the California sweet potato is seen in the Honolulu market as often as the home-grown product. The latter is sold at half the price of the former, the difference in price being in large measure due to inferior grading and packing for market of the home-grown article.

TARO.

The taro plant is used in making poi and as a vegetable. As it is generally cultivated as an aquatic, the sections chosen for its growth are near a water supply. The mountain streams are nearly all diverted during their course to the sea into the taro patches (rice and taro land may be used interchangeably), so the sections where taro is grown are the low plains or slopes of the valleys. (Pl. XXX, fig. 1.)

Cultivation.—The land is divided into patches varying from one-thirtieth to one-fourth of an acre. The patches are arranged in terraces separated by dykes, thus allowing the water to run from the upper to the next lower terrace.

The tops of the plants are cut when the crop is harvested, and these in turn are planted, and in time will make the new crop. It requires from ten to fifteen months for a crop to mature, the only work neces-

sary during this period being to keep the patch well irrigated and free from weeds.

The growing of taro, although local, is an occupation of much importance to the islands. Extinction of this crop by other industries would be as great a hardship to the poorer classes of people as a wheat famine would be in the rest of the United States. While formerly taro growing was an industry confined entirely to the natives, it is gradually falling into the hands of the Chinese, and fully 50 per cent of the taro is now grown by Chinese, and 80 per cent of the poi is made by Chinese.

Taro lands rent for $40 to $50 per acre per annum. The yield per acre is from 6 to 10 tons. Taro sells at from 1½ to 5 cents per pound. One grower claims that 4 acres will yield a gross receipt of over $3,000.

The production of taro is roughly estimated to be worth about $100,000 to $150,000 per annum, and thus it will be seen that the industry is one of importance and must be fostered even to the sacrifice of some others.

The supply of taro is being cut down to no little extent by the taro disease, which causes a rotting of the tuber until often the whole plant becomes useless. This disease is undoubtedly encouraged by the depletion of the soil, as taro is grown year after year on land without fertilization. In some cases the loss has been 80 to 90 per cent of the yield, while the average loss is 50 per cent. Experiments are being carried on by the experiment station relative to this disease, and so far the results are encouraging.

The growing of taro need not be limited to small sections of irrigated lands, for there are varieties that thrive in the uplands where there is plenty of rainfall. This is called upland taro, and is less subject to disease than the lowland or water taro, and the poi made from it is of superior quality. (Pl. XXX, fig. 2.) The area of land adapted to its culture is very extensive, and the output from this land would exceed that of water taro many times.

There are about 40 varieties of taro; some are suitable for cooking as a vegetable, while others are better for poi. There is room for selection and improvement in the varieties of taro.

Poi is the staple food of the Hawaiians. It is made from the root of the taro, which is boiled, peeled, and mashed to a pulp. A little water is added until the consistency is that of paste.

The older white settlers find poi a palatable article of diet, and in this connection the food problem for our new tropical possessions might be considered. Poi is nutritious and in the partly fermented condition is very digestible, thus rendering it a good food for people living in the tropics, where stomach troubles among the white settlers seem to be very common.

FIG. 1.—HAWAII STATION—WOMEN WORKING IN TARO FIELD.

FIG. 2.—HAWAII STATION—UPLAND TARO AND BANANAS.

FIG. 1.—HAWAII STATION—PLOWING FOR RICE WITH WATER BUFFALO.

FIG. 2.—HAWAII STATION—HARVESTING RICE.

FIG. 1.—HAWAII STATION—MARKETING RICE.

FIG. 2.—HAWAII STATION—DUCK POND NEAR HONOLULU.

RICE.

Rice is grown almost exclusively by the Chinese. (Pl. XXXI, figs. 1 and 2.) Its preparation for market in many sections is very crude, the flail often being used to thrash the rice, while grading is done by hand sieves, and transportation is by means of pack mules or hand-carts. (Pl. XXXII, fig. 1.) New methods and modern machinery, however, are being introduced.

The market price of rice ranges from 5 to 7 cents per pound. Rice lands rent for $40 to $60 per acre per annum. The production of rice is from 30 to 43 barrels per acre, or 5,000 to 7,000 pounds. As five crops can be grown on a given piece of land in three years, the average yield per acre per annum is 48 barrels, or 8,000 pounds. The area of rice land has decreased to some extent, owing to the introduction of sugar cane on the rice lands which were available for that purpose. At the present time rice is being imported for home consumption. The largest export of rice was during the year 1887, when 13,684,200 pounds were exported. Exports of rice have diminished to about one-fifteenth of that of 1887. The imports are upward of 250,000 pounds annually.

"KLU" BEAN, OR CASSIE.

The islands offer opportunities for the encouragement of some minor industries, such as spices, vegetable oils, and aromatic plants. Among the latter may be mentioned the Cassie flower. India furnishes much of this product, and in southern France there are plantations devoted to the cultivation of the Cassie flower. In Hawaii the plant grows luxuriantly and is found along the roadsides and in rocky and otherwise unproductive sections. Experiments have proved that the quality of the flowers after proper curing equals if not excels those produced in India. The price paid for Hawaiian-grown flowers is 60 cents per pound.

DUCKS.

Duck raising, which is entirely in the hands of the Chinese, has come to be an industry of some proportions, representing about $30,000 per annum. Ducks sell for $6 per dozen. The demand is so great that almost every available pond around Honolulu is utilized as a duck pond. The Chinese are remarkably successful in rearing the birds and keeping them free from disease. A Chinaman may have over 2,000 ducks in his flock, with only half an acre for ponds and runs. (Pl. XXXII, fig. 2.)

CHICKENS AND TURKEYS.

The raising of chickens is attended with many difficulties, among which are chicken pox, roup, and chicken cholera. The mongoose, also,

is responsible for much of the trouble. Chickens flourish better in the higher localities. In earlier days chickens were apparently plentiful and sold for $3 per dozen, while now the market price is $15 per dozen, much of the local demand being supplied by imported fowls. The chicken industry, including eggs, amounts annually to $25,000 or more.

Turkey raising seems to be attended with the same difficulties as chickens. The price paid for dressed turkeys is about 30 cents per pound. In the mountains there are wild turkeys, or rather domesticated turkeys, which have found their way to the mountains and have reared broods. This seems evidence that turkeys might be raised under proper conditions and put on the market at reasonable prices.

SUGGESTED LINES OF INQUIRY.

The economic conditions of Hawaii are such that new industries can be established only with the greatest difficulty. In common with all other old insular regions there has been a multitude of serious insect and animal pests introduced, not through intent but as a concomitant of commerce. In this regard the history of Hawaiian agriculture is parallel with that of many other tropical islands, such as the Fiji Islands and the British West Indies. Plants may be introduced without their insect enemies, or insects which in their native country are kept in check by natural enemies, and parasites may here breed in enormous numbers and adapt themselves to new host plants, to the detriment of the farmer. Hawaii is full of ornamental exotics which have become weeds, and of Chinese, Japanese, Australian, American, and Old World insects which, free from all natural check, ravage alike the native vegetation and the cultivated crops. The lot of the farmer is thus in a way more difficult than in continental regions. The battle is a continuous one. The practical entomologist thus finds here a wider field for work, and although much has been done, a vast amount of work is yet to be accomplished. Some crops are abnormally free from blights and disease. Others fall a ready prey to hosts of enemies whose attacks the plants themselves are not prepared to resist nor do the farmers know how to combat. What is true of insect pests is also true of fungus and bacterial diseases. The field of investigation is a new one, hardly yet touched upon.

Lower world's prices for sugar means a narrowing of the margin of profit. With such a fall in prices and profits must come the substitution of more careful handling, better cultivation, conservation of the irrigation water (where used), and a more skillful fertilization of the soil. The Hawaiian sugar planters are prone to ignore these factors and to ascribe all of their benefits to cheap labor. If planters in other parts of the tropics can grow sugar at a profit in the open competition

of the world's markets and in spite of the American duty on this product, there is still hope for greater reward in store for the Hawaiian grower. Investigations as to cultivation and the most efficient use of water would well repay. In this connection and as an aid to the future development of this island group a comprehensive soil survey of all the agricultural lands would save to the men who are to develop the resources of the land millions of dollars. Much experimental work has been done in trying to grow this or that crop. A soil map of the islands would, in case some one crop were found which grows better here than anywhere else, indicate exactly in what other regions this crop would be most likely to succeed. There is hardly a crop cultivated in all the subtropical regions of the globe but which has been grown here at some period during the past eighty years. Fruits, nuts, dyes, tannins, precious woods, spices, vegetables, drugs, fibers, and forage plants have been grown in endless variety. The castor-oil bean is grown in Kona and finds ready sale at $60 per ton. Tea is almost a weed in Olaa and Hamakua. Vanilla thrives in Kau, and the cocoanut in Puna. There are large trees of cacao, the source of chocolate, in the city of Hilo, and the African oil palm lines the streets of Honolulu. Tobacco of excellent quality has been grown on all the islands. The opportunities for work in lines where practical agricultural benefit will result are so many that it is difficult to choose what first to undertake.

Investigations in forestry are much to be desired, but these can not be undertaken by the station without considerable increase in its resources; and, in any case, whatever investigations the station might undertake in this direction should be done in cooperation with the Bureau of Forestry.

Many of the native woods of this group are extremely valuable from a commercial standpoint, and a considerable trade in these woods, notably koa and sandal, at one time flourished. It would be well if the entire backbone of each main mountain chain of each of the islands be set apart in forest reserves under the Federal Government, in order that the native forests may be protected and preserved and that a modern and legal system of forest conservation may be carried out. The sugar plantations all depend directly or indirectly on the wooded mountain slopes for their water supply, and it is due to their owners that something be done to check the further destruction of the native forests, and also to replant large areas with trees (native and foreign) which shall in the future become commercially valuable.

The station has already attained a sure footing in Hawaii. Many inquiries in regard to local problems in agriculture have been received and answered, and the interest in the station is constantly growing. If sufficient money can be appropriated to provide a suitable permanent equipment, results will the sooner be obtained.

ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION FOR 1901.

By F. D. Gardner, *Special Agent in Charge.*

INTRODUCTION.

The first appropriation for agricultural investigations in Porto Rico was made for the fiscal year ended June 30, 1901. This appropriation was $5,000, and authorized the Secretary of Agriculture to determine the agricultural conditions existing in that island with special reference to the most desirable localities for agricultural experiment stations, as well as the subjects on which the agricultural people of the island are in most immediate need of practical information, and how this need can be most economically and effectively supplied; but it did not provide for the establishment and maintenance of an experiment station. The preliminary investigation called for by this appropriation was made through the Office of Experiment Stations by Prof. S. A. Knapp, formerly of the Iowa Agricultural College, and more recently engaged in agricultural enterprises in southern Louisiana. He visited Porto Rico during the summer of 1900, and made his final report in September of that year. This report was transmitted to Congress and published as House Doc. No. 171 (Fifty-sixth Congress, second session). It contains a summarized statement regarding the climate, soil, and agriculture of the island, shows in what ways the experiment station might benefit agriculture, and recommends the establishment of a station as soon as practicable. Professor Knapp advises that the station should give immediate attention to promoting the production of larger and better crops of coffee, sugar, and tobacco, and food products for home consumption, and that at an early day work should be undertaken in horticulture, forestry, animal husbandry, and dairying. Besides conducting experiments, it should give object lessons in improved farming and should disseminate information by publications and agricultural meetings.

On the basis of this report Congress made a second appropriation ($12,000) for the current fiscal year, which authorized the Secretary of Agriculture "to establish and maintain an agricultural experiment station in Porto Rico, including the erection of buildings, the printing (in Porto Rico), illustration, and distribution of reports and bulle-

tins, and all other expenses essential to the maintenance of said station."

Though this appropriation did not become available until July 1, 1901, the writer, then assistant in the Division of Soils of this Department, was transferred to the Office of Experiment Stations April 15, 1901, and was appointed to take charge of the agricultural investigations in Porto Rico. After spending some time in such preliminary preparations as could best be conducted in Washington and vicinity, he proceeded to Porto Rico, arriving in San Juan about the middle of May. The remaining portion of the fiscal year he spent mostly in traveling about the island to familiarize himself with its people and the conditions and needs of agriculture, with special reference to the location of the experiment station and the character of experiments most desirable to undertake. During a portion of this time he was accompanied by Messrs. O. F. Cook and G. N. Collins, of the Division of Botany, of this Department, who had been temporarily assigned to this Office and sent to Porto Rico to aid in preliminary studies with reference to the determination of the best lines of work for the proposed experiment station.

As regards the location of the experiment station, more difficulty was experienced in obtaining suitable land than was anticipated. Replies to a circular letter sent to the different municipalities in the island, setting forth some of the advantages of an agricultural experiment station, and asking how much land they would donate for the purpose of establishing an experimental farm in their vicinity, as a rule, stated that the municipalities possessed no lands that in kind and amount would be suited for the purpose, and that their very poor financial condition would not allow them to purchase. Three municipalities, however, made offers of land, but on examination it was found to be either not suitable for experimental purposes or too inaccessible.

When it became apparent that the station could not be permanently located without considerable delay, arrangements were made for conducting experiments on a temporary basis. Thirty acres of land adjacent to the town of Rio Piedras has been leased, together with a large frame house which serves as a residence and office for the special agent, and also furnishes accommodations for laboratories and library. In addition to this, the local normal school has donated temporarily the use of 40 acres of land for experimental purposes. The necessary horses, mules, and oxen have been secured and a stable constructed for their shelter. A farm wagon, an ox cart, and several plows and harrows, together with garden and horticultural tools, have been secured. A portion of the land has been cleared of weeds, banana stumps, etc., and plowed. The experiments include tests of various kinds of plants, and experiments regarding the time and manner of planting, the use of fertilizers, etc. A cooperative experiment has been commenced on

a coffee plantation, with the object of improving methods of growing coffee in Porto Rico. This consists of an attempt to improve the yield and quality of coffee by selection, breeding, and propagating, and in restoring old groves by removing part of the shade and thinning and pruning. Investigations have also been begun to discover means for combating certain troublesome insects, especially the "changa," a kind of mole cricket, and various scale insects, and the fungus diseases affecting citrus fruits.

The Bureau of Soils of this Department, in cooperation with the station, has undertaken a soil survey of a portion of the island. A considerable number of different kinds of vegetable seeds have been distributed to farmers. The beginning has been made of a collection of improved farm implements and machinery of the kinds adapted to the tropical agriculture of the island. In this work the station has been greatly aided by different manufacturers in the United States. It is believed that in this way useful information regarding improved implements will be disseminated by visitors to the station.

The organization of a regular station staff has been begun, the force now including the special agent in charge, the entomologist and botanist, and farm foreman.

It is hoped that land may be obtained for the permanent location of the station in the near future and that it will be possible to greatly develop the work of the station during the coming year. Considering the large agricultural interests of the island and the variety of work which needs to be done by the station, the appropriation for its support by Congress should not be less than $15,000 per annum. In addition to this, money will be needed for the purchase of land, erection of buildings, and equipment of the station. The station will, therefore, need such financial assistance from the Territory of Porto Rico as was given in the other States and Territories.

There are no results of experimental work to be reported at this time. This report is, therefore, chiefly confined to a statement of the agricultural conditions and needs of the island as seen by the writer in the course of such an agricultural survey as he has been able to make in the space of nine months.

AGRICULTURAL RESOURCES AND CAPABILITIES OF PORTO RICO.

LOCATION AND EXTENT.

Porto Rico is situated between $65\frac{1}{2}°$ and $67\frac{1}{4}°$ east longitude and $18°$ and $18\frac{1}{2}°$ north latitude. It is therefore approximately $5°$ south of the Tropic of Cancer or well within the Torrid Zone. It is roughly, $11°$ east and $22°$ south of New York City, or $12°$ south by $24°$east from New Orleans. The air-line distance from the island to New York City

is about 1,400 miles, while the distance to New Orleans is slightly greater.

In form the island is a parallelogram, with its long axis extending almost due east and west. In extent it is 36 miles wide by 100 miles long, embracing an area of 3,600 square miles.

CONFIGURATION.

The topography of the island consists chiefly of interior mountains and coast border plains, the latter representing only about one-tenth of the whole. The formation of the island is volcanic, the rocks consisting principally of limestones, together with small amounts of granite, marble, sandstone, and serpentine. The limestone varies greatly in its character and hardness. In the interior it is usually of a blue or grayish crystalline nature, and well adapted for burning into lime, although but little used for this purpose. The surface of these rocks is almost entirely disintegrated, forming a soil several feet in depth, which gives to the mountains a smooth appearance and furnishes a good footing for vegetation. Along the marginal foothills the limestone is of a white and chalky appearance, and is sponge-like in texture. It is usually spoken of as coral limestone, and the cavities often contain seashells. This coral limestone gives rise to foothills, having very steep acclivities, and terminating in very sharp and jagged points. The rocks are more exposed than in the interior, but their porous nature furnishes a good footing for plants, and the hills are usually covered to their summits with verdure. These rocks are much used in the construction of roads.

The main backbone of the island extends almost due east and west and is fully two-thirds of the distance to the south side. The watershed of the north is therefore twice as extensive as that of the south, and because of the greater rainfall on the former, the rivers are more than correspondingly larger.

The coastal plain consists chiefly of level stretches of alluvial land which in places takes on an undulating aspect. In a number of places this coastal plain is broken by the mountains coming directly to the seashore. It rarely extends inland more than 5 miles and the greatest breadth usually occurs at the mouth of the larger rivers.

The interior mountain country is cut by numerous streams which ramify in every direction and give rise to deep but very narrow valleys. The river bottom lands are in small irregular areas which occur first on one side of the stream and then on the other as it sweeps the valley from side to side in its course to the sea. In many places no bottom lands are present, the valley being so narrow that it is occupied only by the rocky bed of the river.

In a few instances the valleys widen out into a considerable area of bottom lands. The most noted example of this is at Caguas, where

occurs a considerable area of level land, now devoted to the growing of sugar cane. This, however, is supposed to have been a coastal lagoon or lake, which became filled with sediment and was brought to its present elevation (about 250 feet) and position by the uplifting of the island.

The mountains, while rugged, scarcely ever exceed 3,000 feet in elevation. No topographic survey has ever been made of the island, though one is much needed, and, consequently, reliable data as to elevations are wanting. The highest eminence is attained on El Yunque, in the northeast part of the island. Spanish maps give this mountain an elevation of 4,087 feet, but other authorities give it as much less, the minimum being 3,200 feet. These mountains may be considered nothing more than the peaks of a part of a great mountain chain, which, if wholly emerged, would exceed in elevation any mountains on the North American continent. To the north the shore of the island drops off rapidly, and within less than 75 miles the water attains a depth of 4,600 fathoms, or more than 5 miles.

The elevations of Porto Rico are not sufficient to cause any marked change in temperature, but owing to the prevailing direction of the winds they have a marked effect on the distribution of the rainfall. The combined influence of soil, rainfall, and elevation, however, has a marked effect upon the character of the vegetation and makes climatology a subject of vast importance.

SOILS.

The soils vary much both in formation and texture. About the shore occurs a narrow fringe of coarse coral sand, which results chiefly from the breaking down of the coral growth that is continuously in process in the waters near the shore. This soil, with its accompanying salt-water climate, is adapted to a comparatively limited flora, which is quite distinct from that of the interior. Here the cocoanut palm, yarey palm, and the sea grape find a congenial home, and the soil seems well adapted to the growing of pineapples. Bordering this to the landward are two types of soil, viz, the mangrove swamps and the playa plains. The former are swamp areas, which are about midway between high and low tide in elevation and are, therefore, inundated to the depth of about a foot by every rise of tide. The soil is often made up of a mixture of the coral sand and the finer material which is brought down from the interior, together with much organic matter resulting from the decay of the falling leaves of the mangrove bushes, which gives to the soil a black color. The soil is necessarily charged with salt and has no economic value except for the purpose of future reclamation by diking and pumping.

The soils of the playa plains, owing to the sources of their origin, vary much in character. They are all alluvial, however, and brought

down from the interior. On the north side of the island they usually consist of sandy loam, or loam which is underlaid at a depth of 12 inches by a medium clay. They are level, and when properly drained and cultivated make excellent sugar and pasture lands. On the south side of the island this soil is much deeper and usually more sandy as well as darker in color. For the production of sugar it requires irrigation during the dry season.

Bordering the playa plains are the foothills or mountains, the soils of which are dark in color. Farther inland, however, the soil is usually of a heavy red clay. The soils are adapted to coffee, citrus fruits, bananas, tobacco, and various other minor crops, the heavy clays being especially well adapted to coffee.

The coral sands and the playa plains are so level that improved machinery could be used to very good advantage in their cultivation, but the interior country is so rugged that it prohibits the profitable use of the most of our horse machinery.

The accompanying table gives the mechanical analysis of samples of soil and subsoil from various parts of the island:

Mechanical analysis[a] *of soils and subsoils from Porto Rico.*

No.	Locality.	Description.	Gravel larger than 2 mm.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5918	Cayey, 5 miles W.	Tobacco land, 0 to 18 inches.	45.9	8.16	1.74	5.30	4.70	15.32	12.20	27.10	26.18
5925	Rio Piedras........	Sandy soil, 0 to 10 inches.	Tr.	3.76	1.02	19.76	15.60	25.60	8.64	9.08	15.02
5926	.....do............	Subsoil under 5925, 12 to 30 inches.	.7	5.14	1.66	12.28	11.46	23.00	7.80	7.10	30.98
5916	Mayaguez........	Heavy loam, 0 to 18 inches.	2.9	11.62	.46	1.92	1.42	5.50	7.80	29.18	42.26
5917	.....do............	Lowland, 0 to 12 inches.	2.9	11.54	.26	.50	.32	1.16	1.34	18.66	65.80
5920	Yauco, 3 miles SW.	Cane land, 0 to 12 inches.	2.5	6.74	1.16	3.30	2.40	7.82	7.42	23.30	48.20
5924	Ponce, 3 miles E..	Cane land, 0 to 18 inches.	2.4	7.32	.46	1.88	1.58	5.84	6.64	29.78	46.38
5921	Mamayes post-office.	Virgin forest, 0 to 6 inches.	Tr.	15.24	.22	.44	.46	1.24	1.28	19.46	61.18
5922	.....do............	Good coffee land, 0 to 6 inches.	Tr.	10.06	.08	.34	.36	.70	1.04	12.74	75.32
5923	.....do............	Subsoil under 5922, 6 to 24 inches.	......	8.26	.00	.12	.14	.86	1.46	11.90	77.84

[a] Made by the Bureau of Soils, U. S. Department of Agriculture.

Sample No. 5918 is representative of the hillside soils of the Rio La Plata which are used for tobacco. The analysis is of material smaller than two millimeters in diameter, and takes no account of 45.9 per

cent of angular gravel or broken stone which the sample contained. This soil contains a considerable percentage of sand, which, together with the contained stone, makes it loose and friable. It admits of the ready permeation of rains, and retains moisture well.

Nos. 5925 and 5926 are soil and subsoil, respectively, from level land at Rio Piedras which has been leased for cultural experiments by the station. Owing to its sandy nature it was considered especially well adapted to the growing of annual crops, particularly vegetables. The soil to 10 inches in depth is sufficiently sandy to make it easy of cultivation, while the subsoil at 12 to 30 inches contains sufficient clay to make it retentive of fertilizers and yet sand enough to make good drainage comparatively easy.

Nos. 5917 and 5916 are from the land of the Agronomic Experiment Station, which was maintained at Mayaguez by the Spanish Government from 1889 to 1897. This land, consisting of 7 acres, is of two types—a low, level portion classed as a heavy loam and adapted to the growing of sugar cane and grass, and a hilly part classed as a red clay. The latter is a heavy refractory clay, identical with that of the best coffee lands of the interior. It contains an aggregate of 3½ per cent of sand and larger amounts of silt and clay. The content of organic matter is not real, for in soils of this character the loss in heating to 100° C., is partly due to the loss of water of crystallization. If of higher elevation and farther removed from the coast this would be typical coffee land.

Nos. 5920, from near Yanco, and 5924 from near Ponce, are from the heavier type of loam soils now used for the growing of sugar cane on the south side of the island. Their content of clay and silt is sufficiently high to demand careful management in irrigation and cultivation.

No. 5921 is the surface soil, 0 to 6 inches, from a virgin forest in Mamayes. This soil is almost wholly silt clay and organic matter. The high content of the latter is due to a considerable coating of vegetable mold, the result of the decaying leaves from the forest. This land, when cleared, will be typical for coffee.

Nos. 5922 and 5923 are the soil and subsoil from a young coffee plantation at Isolina, Mamayes. The soil is red in color and very heavy in texture. It clings tenaciously to the sidehills, which are so steep that good drainage is always afforded, and even with the torrential rains is subject to but little washing. As will be seen from the analyses, this is a very heavy soil, and in case of the subsoil contains less than 3 per cent of all grades of sand. It is considered representative of the best coffee lands of the interior. These analyses emphasize the extremely heavy texture of the mountainous coffee lands, and enable one to better understand why so little of the soil is carried away from the steep slopes by the torrential rains.

CLIMATE.

The climate of Porto Rico is characterized by a very uniform temperature, abundance of rain, plenty of sunshine, high relative humidity. and moderate to slow wind movement. The mean annual temperature for the island is about 78° F. The warmest weather occurs in July, August, September, and October, and the coldest in January and February. The difference in temperature, however, between the hottest and coldest month is only about 8° F. The changes from day to day and from month to month are so slight that they are scarcely perceptible. The greatest annual difference in temperature in different parts of the island, as determined by seventeen United States Weather Bureau stations in 1900, was only 4.8° F. The mean temperature is slightly lower in the elevated parts of the island than along the seashore. The weather is perpetual summer, with three hundred and sixty-five growing days in each year.

The annual rainfall varies greatly, attaining a maximum of 140 to 150 inches in the northeast part of the island, near El Yunque, and a minimum of about 40 inches in places near the southern coast.

The following table shows the monthly precipitation for each of four localities on the island since the establishment of observations there by the United States Weather Bureau. Prior to that period the only continuous record is one that was kept at San Juan by the Spanish Government. The mean of this station for twenty-six years is as follows: Temperature, 78.5°; rainfall, 54.51 inches.

Rainfall (inches) in Porto Rico as recorded by the United States Weather Bureau, January, 1899, to December, 1901.

Locality.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Hacienda Perla:													
1899	7.19	3.98	6.51	18.78	6.72	11.47	10.55	9.92	15.43	16.53	28.13	4.92	140.06
1900	12.05	3.67	4.43	23.34	18.70	18.55	11.04	11.95	15.30	15.83	8.36	8.70	151.92
1901	6.07	1.85	11.03	7.05	16.26	25.34	33.58	8.19	16.10	14.16	16.43	......	......
Mean	8.44	3.17	7.32	16.39	13.56	18.45	18.39	10.02	15.61	15.51	17.64	......	......
San Juan:													
1899	2.92	.80	2.29	6.09	2.59	7.23	7.53	10.38	13.66	10.21	11.81	2.10	77.61
1900	3.93	2.13	1.57	5.92	3.83	7.53	6.33	7.00	3.05	8.11	4.50	2.39	56.29
1901	4.36	.50	4.60	.66	4.84	7.05	10.98	8.59	7.39	8.30	9.55	......	......
Mean	3.74	1.14	2.82	4.22	3.75	7.27	8.28	8.66	8.03	8.87	8.63	......	......
Mayaguez:													
1899	......	......	......	......	......	......	14.41	19.02	......	8.73	3.52	1.04	......
1900	1.49	1.06	1.21	5.44	6.14	14.03	13.11	14.02	7.44	12.47	2.99	4.20	83.57
1901	2.19	.58	5.72	.58	11.87	10.44	17.06	9.86	13.00	11.27	12.84	......	......
Mean	......	......	......	......	......	......	14.86	14.30	......	10.86	6.45	......	......
Hacienda Armistad:													
1900	4.25	.80	1.00	1.10	2.80	16.30	5.50	2.20	4.80	4.46	3.83	4.22	51.26
1901	2.60	1.14	2.63	.32	6.30	4.84	......	6.03	7.97	6.30	13.97	......	......
Mean	3.42	.97	1.81	.71	4.55	10.57	......	4.12	6.38	5.38	8.90	......	......

A study of the above table shows that the montly rainfall goes as high as 33.58 inches and as low as 0.50. A rainfall of 10 or more inches in twenty-four hours is not uncommon. In July of the present year a rainfall of 17 inches in twenty-four hours is recorded at Hacienda Perla and of 10 inches in twenty-four hours at Adjuntas. The table also shows that the driest months of the year are January, February, March, and December. The dry season, as these months are called, varies in time and duration from year to year and also varies for different portions of the island. On the south side of the island the dry season often continues into the month of July. During the present year the fields all along the south side of the island not under irrigation were in a brown and parched condition as late as July 1.

The prevailing wind is from the northeast, and in rising to pass over the mountains it is cooled to such an extent that a part of its heavy charge of humidity is condensed and falls as rain on the north side of the island. It is for this reason that the rainfall of the north slope so far exceeds that of the south. As a rule the rains occur as showers, often torrential in character, and most frequently in the afternoon. After the rain the sun again shines and nature soon resumes normal conditions. Owing to the torrential character of the rains a large part of the water finds its way into the streams, which rush madly down the steep slopes on their way to the ocean. The streams rise very quickly and often become such raging torrents that it is impossible to cross them, and there is nothing for the traveler to do but to wait for them to subside, which they usually do in a few hours. During the rainy season, however, the showers may be so frequent that the streams will continue very high for several days, thus stopping for the time all communication between different parts of the island. Excepting on the first-class roads the streams are without bridges, and even here some of these have been destroyed by the floods and will have to be replaced at a cost of many thousands of dollars.

Fogs are very common in the mountains during the early morning and often settle in the valleys so as to entirely obscure the view of one standing on the mountain top.

As a whole the climate is healthful. There is usually a breeze, and though the temperature is uniformly high it is seldom excessively warm or oppressive. With a little care people from the temperate climate need have no fear of disastrous results from the climate. It is well to avoid the sun between 11 and 2 o'clock, for at that time of the day it is almost directly overhead and very hot.

SANITARY CONDITIONS.

In the cities and towns the sanitary conditions are very bad because of the lack of city water and sewerage, and the prevalence of vaults that have been in use for several hundred years. (Pl. XXXIII, fig. 1.)

In the larger places, however, these foul conditions are being ameliorated by the installation of waterworks and sewerage, together with sanitary plumbing.

Each house usually has a water-tight cistern, which collects the rain water from the roof that is used for culinary and drinking purposes. Before using this water is passed through an earthen-ware filter to insure its purity. Since water is so often the conveyor of diseases, especially of fevers in tropical countries, it is well to boil all water used for drinking, thus destroying all germs that it may contain.

The laundering is practically all done in the streams. (Pl. XXXIII, fig. 2.) The laundress takes her pack of clothes on her head and wends her way to the nearest stream, where she sits on a rock and washes the clothes directly in the water. The clothes are afterwards spread on the dry rocks or the near-by bushes to dry. This universal habit of washing in the streams practically prohibits the using, with safety, of river water for drinking.

The houses are usually built upon piles or posts, being elevated 2 or more feet above the ground, thus giving them better ventilation and drier conditions as well as lessening the intrusion of vermin and insects. Many of the huts of the very poor, however, are built directly on the ground and without any floors, the occupants sleeping in hammocks or sometimes on the ground.

The native Porto Rican is much opposed to the night air, and therefore upon retiring he closes all of his windows and doors as tightly as possible. As large families often occupy a single room the air becomes very foul. It is believed that good ventilation, even in the night, would be conducive to better sanitary conditions.

The diet of the people varies greatly. For the very poor it consists of what they can most easily obtain with the least expenditure of either money or energy. Native fruits that grow practically wild often form a large part of their living. Rice and beans are two staple foods, and are found on the table of the rich as well as the poor. The people who can afford it eat much meat, and oils and lard are very freely used in cooking. It seems probable that animal foods are used to a much greater extent than is conducive to the best of health, especially in so warm a climate. Vegetables and maize should replace a part of the present meat diet of the people.

Naturally very little clothing is necessary, and the children of the poor, often to the age of 10 years, dispense with it.

It is not strange that in the North, where the winters are long and cold, that some people should be unable to supply the necessaries of life, but it seems almost incredible that in a tropical country, where planting and sowing can be practiced every day in the year, and where land is plenty, the mass of the people should be poverty stricken. Such, however, is the case in Porto Rico, and the reason is not on the surface of things, but is down in the primitive foundation of society.

Fig. 1.—Porto Rico Station—Street Scene in Caguas.

Fig. 2.—Porto Rico Station—Washing Clothes.

LABOR.

The labor problem is one which the Northern man will find more or less perplexing. While the wages of laborers are low, it is doubtful after all if it will be found cheap. The agricultural laborer in Porto Rico is as a rule ignorant and unskilled. He has no interest in the work he is performing for his employer, and consequently requires constant supervision, otherwise he will either not work or will do things wrong. He has no desire to rise in the world or to accumulate a small property, even for a home, and when he gets a few days' wages ahead he prefers to stop work until he has spent them. There is much to be done in improving the energy and skill of the agricultural laborer. There are great numbers of men who know how to do nothing but wield a machete or a hoe. Many of them have never driven an ox team or harnessed a horse, and to do the latter properly would for them be an absolute impossibility. The training of these ignorant people in the use of the spade, scythe, ax, pruning knife, spraying apparatus, and the operation of hand and horse machinery means a revolution in the agriculture of the island, and an output of products never before equaled in its four hundred years of Spanish rule and history.

TRANSPORTATION.

Intimately related to the agricultural development of the island is the development of transportation facilities. This naturally divides itself into interior and exterior transportation, but it is the former which most concerns the people of the island. The latter will be provided for them when the demand for it is sufficient to justify, but the former must be provided for by the expenditure of several millions of dollars, which must ultimately come from the sources that are thereby benefited. The crying need throughout the island is for roads and more roads. At present the construction and maintenance of roads is entirely vested in the insular government, the districts, barrios, and municipalities having no responsibility in them whatsoever. Quite an elaborate system of first, second, and third class roads have been laid out for the island, but a number of years will necessarily elapse before these roads can be constructed, and even when completed there will still be an urgent demand for still further road building in order to reach all of the people.

The topographical character of Porto Rico makes road building comparatively expensive, and the torrential rains make prompt repairs and maintenance imperative or they soon go to destruction.

To give an idea of the cost of road construction in the island, attention is called to the present military road extending from the capital to Ponce and Guayama, together with a few shorter sections in various other places. These roads, built under the Spanish Government,

aggregate 157.7 miles, and cost approximately $3,485,000, or at the mean rate of about $22,000 per mile. (See Pl. XXXIV, figs. 1 and 2.)

This is all first-class road, but fully one-third of it is on nearly level country, and required very little grading. The roadbed is macadam and of excellent surface, but is usually only sufficiently wide for ox carts to pass. Since American occupancy, about $1,000,000 have been spent on roads under the military government, and the present insular budget carries an appropriation of about $700,000 for roads out of a total appropriation for all running expenses of the government amounting to only $2,000,000.

The system of roads as now planned, including those already constructed, embraces 874 miles. On the basis of the former cost, $22,000 per mile, it will require about $14,000,000 to complete the system. Under the present management, however, and in view of the fact that part of these roads are second and third class, the total cost will probably be much reduced. It would seem advisable that, for the extension of this system so as to reach all the people, the island be divided into road districts, with a superintendent in charge of each. There should be a poll tax, with the option of working out the same on the roads under the direction of the superintendent. A small amount of labor on the present bridle paths might at least make them passable, whereas they are now at times impassible on account of the lack of care. The interior of the island is filled with idle men who could work almost any number of days on the roads with very little inconvenience to themselves, and much to their own and the island's ultimate advancement.

In railways the island is quite as deficient as in roads. The steam railways consist of disconnected sections, as follows: From San Juan to Carolina, San Juan to Camuey, Aguadilla to Hormigueros, Ponce to Yauco, aggregating in all 135 miles. There is an electric-car line from San Juan to Rio Piedras, 7 miles distant, and a horse tramway in the town of Mayaguez.

There are now areas aggregating 50,000 acres of land in a body for which there are no means of getting their produce to market except on the heads of peons or backs of mules and horses. No road passable by even an ox cart is accessible to them. Such conditions place a handicap on agricultural development and confines it to lines requiring the minimum amount of interior transportation.

LAND VALUES AND TAXATION.

Under Spanish régime most of the revenues were acquired by a consumption tax, and was therefore borne by the poorer classes. Under an American administration, however, it was found advisable to make a radical change in this respect, and therefore a property tax has been

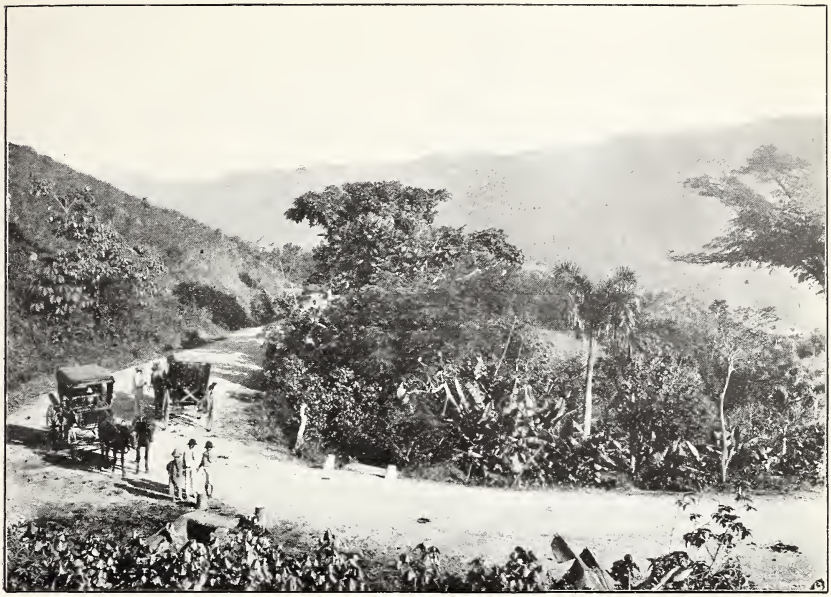


FIG. 1.—PORTO RICO STATION—MILITARY ROAD BETWEEN CAYEY AND CAGUAS.

FIG. 2.—PORTO RICO STATION—MILITARY ROAD NEAR COAMO.

levied, with a marked increase rate of internal-revenue tax on liquors, cigars, etc.

Formerly the landowners paid no tax on their holdings, and as a consequence many proprietors held large bodies of undeveloped and unused land with no expense. The present method of taxation makes the ownership of land an expense, and will probably result in causing much of the land either to be used for agricultural purposes or to be placed upon the market. Where lands are not on the market and not being bought or sold it is difficult to quote prices. In a general way, however, there is very little land that can be purchased for less than $10 per acre, even when remote from roads and without improvements. Near good roads or near the towns and cities the prices advance. Cane lands vary in price from $70 to $200 per acre, according to kind and condition; coffee lands without coffee on them from $10 to $30, and with coffee trees in bearing, from $50 to $150, according to kind, location, and improvements. There are very few coffee plantations, however, that under the present depression for that crop can not be bought for $100 per acre, and there are many that can be purchased at $60 to $70 per acre. Pasture lands range from $15 to $60 per acre, and will probably advance in price because they are often adapted to sugar, which industry is now in a flourishing condition.

The present law provides for a tax on lands and personal property of one-half per cent of their assessed value for insular purposes, and not to exceed an additional half per cent for local or municipal purposes. The assessed value is very nearly the actual or market value.

Land titles in Porto Rico are very poorly defined, and for many tracts no records are obtainable. This makes the transfer of property very troublesome and the title in lands more or less uncertain. There are considerable areas of Crown lands in the island, scattered about from the shores to the interior mountains, but the records relating to them are incomplete. A list of such lands, as given in the report of the commissioner of the interior for Porto Rico, while acknowledged to be incomplete, shows an aggregate of 100,000 acres. The Crown lands presumably belong to the Federal Government, but no action has thus far been taken in regard to their disposal. It is very essential to have a complete record of lands in Porto Rico, both private and public, put into the care of a competent office. All lands, and all future changes likewise, should be recorded. If necessary, a survey should be made establishing the boundaries of all parcels of land. When Congress takes up the adjustment of this matter it is suggested that a parcel of the public domain be designated for a forestry reserve, and that a limited area be also set aside for the experiment stations to be used for agricultural experiments.

AGRICULTURAL PRODUCTION.

Porto Rico is almost purely an agricultural country. Statistics show that of the exports during many years past 95 to 96 per cent were agricultural products. The chief exports are coffee, sugar, tobacco, and live stock, in the order named. The following table[a] shows the important exports of commodities exceeding $50,000 in value for the years 1894, 1895, and 1899:

Exports of commodities exceeding $50,000 in 1894, 1895, and 1899.

Articles.	1894.		1895.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
Coffee	50,507,159	11,496,082	40,243,693	9,159,985	45,328,298	5,164,210
Sugar	106,723,699	3,169,895	132,147,277	3,905,741	99,160,293	2,670,288
Molasses	15,957,253	244,466	35,219,823	539,571	[a] 3,415,058	647,373
Leaf tobacco	3,369,616	619,474	3,665,051	673,787	3,313,534	331,729
Cattle	4,306	166,212	3,674	141,816		[b] 852,167
Hides and skins	762,197	63,389	646,884	53,799		71,975

[a] Gallons. [b] Cattle are not shown separately; includes all animals.

Of the total exports of the island for the years 1887–1891, inclusive, 28.7 per cent went to the United States, 21.4 per cent to Spain, and 19 per cent to Cuba, with lesser amounts to various other countries, and for the five years ending 1896, 24.8 per cent went to Spain, with 23½ to Cuba, and 15.8 to the United States. Of the total imports of the island for the years 1887 to 1891, inclusive, 24 per cent were received from the United States, 28 per cent from Spain, with approximately 21 per cent from the United Kingdom, and lesser amounts from various other countries. For the five years ended 1896, the percentages are as follows: Spain, 32½; United States, 24; United Kingdom, 13. Since American occupancy, however, this order of importation and exportation has been very much modified and we find that for the year 1899, 40 per cent of the imports were received from the United States, with 20 per cent from Spain and 17 per cent from the United Kingdom, and for the same year, 34 per cent of the exports were sent to the United States, with 21 per cent to France, 13 per cent to Cuba, and only 10 per cent to Spain. During the first year of civil government, ended April 30, 1901, 80 per cent of the imports were received from the United States and 64.6 per cent of the exports went to the same source. This shows a marked increase between the trade of Porto Rico and the United States and we can safely predict that it will continue to increase until 90 or more per cent of both the export and import trade will be between the island and the States. During the years 1887 to 1891, the mean annual excess of imports over the

[a] Figures from Monthly Summary of Commerce of the Island of Porto Rico, April, 1900, War Department.

exports was $1,863,473 and for the following five years the mean was $1,090,453.

Of the imports, slightly more than 40 per cent are agricultural products, much of which might be produced on the islands, thereby reducing the amount of imports perhaps to a less value than the exports, greatly to the benefit of the island. Rice heads the list of imports, and in 1895 reached the enormous amount of 74,145,046 pounds, valued at $2,271,819. Other agricultural imports for the same year, in the order of their value, are: Hog products, $1,274,618; wheat flour, $1,023,694; wines, $431,536; vegetables, $400,660; cheese, $337,790, and canned goods, $178,536.

Of the nonagricultural imports cotton fabrics lead, with a value of $2,070,667, and are followed by fish, valued at $1,918,107.

In speaking of the present financial condition of Porto Rico, the Secretary of the Treasury reports as follows:

Without a dollar of funded or floating indebtedness, with a current income estimated as sufficient to meet the ordinary expenses of the government, with large reserve funds to provide for unforeseen or extraordinary contingencies, and with a lighter burden of taxation upon the real economic life of the island than at any time in its past history, there seems every reason for regarding the financial future of Porto Rico as bright and auspicious.

Statistics show a small falling off in both exports and imports for the past two years as compared with those preceding 1899. This, however, is accounted for by the great damage which was done to the coffee and other industries of the island by the hurricane of August, 1899. The plantations were temporarily ruined, and the value of export coffee for the year was reduced to about half its normal, with large reductions also in sugar and tobacco. The exports of coffee for 1899 are for the calendar year, and a large amount of it is from the crop of 1898. In 1900, the coffee exportations reached the very low value of about $2,500,000. It requires considerable time for a coffee grove to recuperate after being so severely damaged. The crop for 1901 reached nearly its normal amount, but will be much reduced in value because of the very low price at which it will have to be placed upon the market. In the years preceding 1898 the island found a market in France, Spain, Italy, and various other European countries for the greater part of its coffee, at prices ranging from 20 to 35 cents per pound. During the present year, however, the price received for Porto Rican coffee averages about 12 cents, or less than half the average price for ten years preceding 1898.

AGRICULTURAL CONDITIONS.

Agriculture in Porto Rico is primitive and backward. Little is known relating to the growing of any crops other than coffee, sugar, and tobacco, and the cultural methods of these three are very poor. There

is a dearth of skilled labor and an excess of the poorest and most ignorant kind. Improved implements of any sort are rarely used. The roads for getting produce to the local markets and to the seaports are so few that the cost of transportation often exceeds the market value. The home market is limited and the facilities for export transportation are not suitable for perishable produce. Better transportation is imperative. There is need of the introduction of improved machinery as well as of seeds, plants, and animals to take the place of those that are now so deteriorated through lack of selection and proper care that they are valueless. There is a good field for the development of some of the tropical fruits by selection, breeding, and better methods of management and their introduction into good markets. Last, but not least, the people should be taught and encouraged to adopt improved methods and fit themselves for a more intelligent management of agricultural affairs. There is great need for capital for the proper development of the island's resources and there is need for American enterprise to push things. It must be borne in mind that the great mass of the people are very poor and the island is therefore not a desirable place for an American of small means to go unless he knows beforehand that he will be profitably employed. There are many more people there waiting for employment than places to be filled. Capital, however, if judiciously invested and properly managed should give sure returns at a good rate of interest. Under the descriptions and conditions of crops brief suggestions of the possible opportunities for investments in each will be given.

According to a recent estimate the agricultural lands are grouped as follows:

Acreage of cultivated and uncultivated lands in Porto Rico.

	1899–1900.	1900–1901.
Lands planted with—	*Acres.*	*Acres.*
Sugar cane	80,034	82,678
Coffee	180,289	166,164
Tobacco	15,324	13,704
Miscellaneous	104,059	201,815
Pasturage	1,206,593	1,203,206
Woodland	318,897	165,671
Brush lands	25,659	
Not cultivated		138,348
Total	1,932,855	1,971,586

The above figures are taken from the reports of Mr. Juan B. Rodriguez, in his reports to the secretary of the interior for Porto Rico. The most striking change from 1900 to 1901 is the increase in acreage of miscellaneous crops of nearly 100 per cent. The percentage of lands under actual cultivation for the first year was only 18.9 and for the last year 23.5.

Areas cultivated in principal crops in acres—from the census of 1899.

Crop.	Acres.	Crop.	Acres.
Coffee	197,031	Malangas	12,256
Sugar	72,146	Rice	8,667
Bananas	69,380	Tobacco	5,963
Sweet potatoes	37,109	Cocoanuts	5,447
Corn	18,093	Yams	2,098

These figures differ quite materially from those of Mr. Rodriguez in the above table, but it must be borne in mind that the census was taken in November and December, 1899, while Mr. Rodriguez's figures are probably for the fiscal year ended June 30, 1900. The marked difference in acreage of tobacco, for example, is probably due to the fact that at the time the census was taken the tobacco for the fiscal year had not been planted, and the acreage as reported was probably for the crop that had been harvested several months earlier.

COFFEE.

Coffee is by far the most important crop of the island, and as an article of export has exceeded in value that of all other exports combined. The cultivation of coffee was introduced into Porto Rico by emigrants from the island of Haiti. In 1768 the King issued a royal cedula giving to Porto Rico a monopoly of the cultivation of coffee, and relieving or exempting the growers from the payment of any taxes for a period of five years. In 1770 the island produced 7,280 pounds, and in 1776, 11,262 pounds. In 1850, or three-fourths of a century later, the yield had increased a hundredfold, or to 11,783,684 pounds. The lack of suitable market and the time required for coffee to come into full bearing offered very little inducement for planters to extend its cultivation, and progress was consequently slow. In 1876 the United States opened its ports to free coffee. This proved a marked stimulus to the Porto Rican grower, and for a short time large shipments were made to the States. Very little attention was paid to quality, and as the island could not compete with Brazil in price, the market remained for the latter and Porto Rico found a better market in southern Europe.

Quantity and value of coffee exported from Porto Rico during each calendar year from 1887 to 1896, inclusive.

Calendar year.	Quantity (pounds).	Values.	Calendar year.	Quantity (pounds).	Values.
1887	27,670,000	$3,391,000	1892	47,364,000	$9,122,000
1888	51,202,000	6,275,000	1893	49,250,000	11,205,000
1889	37,238,000	4,564,000	1894	50,507,000	11,496,000
1890	43,909,000	5,382,000	1895	40,244,000	9,160,000
1891	41,725,000	5,112,000	1896	58,780,000	13,379,000
Annual average, 1887-1891	40,349,000	4,945,000	Annual average, 1892-1896	49,279,000	10,872,000

The above table shows a gradual growth in the exportation of coffee for the ten years ended in 1896. In this year it reached a maximum of over 58,000,000 pounds, with a value of over thirteen and a third million dollars, or a mean average price of nearly 23 cents per pound. This is a very satisfactory showing and in marked contrast to the present much-depressed condition, which has resulted from a combination of the following circumstances: (1) The loss of the European market largely through the war with Spain and the resulting transfer of the island to the United States; (2) the great damage to the plantations by the cyclone of August, 1899, and the time and capital required to recover from it; and (3) the very crude method used in the production of coffee. By the introduction of modern methods in the cultivation of coffee and the adoption of good business methods in introducing it into the market of the States on its merit there should be a good future for coffee.

The present methods of cultivation are very primitive and consist chiefly of transplanting volunteer trees from old groves to new fields and providing shade by growing trees suited to the purpose. It is common to plant shade trees several years in advance of setting the young coffee trees, and if the shade from them is not sufficient when the coffee tree is to be set temporary shade is provided by planting bananas. The young trees for planting the new groves are volunteer plants which spring from the berries that fall to the ground and are not gathered. These volunteer trees thus represent no selection. They usually grow in dense shade, and are consequently spindling and lacking in the form and vigor which is desirable for nursery stock. These trees, usually about a foot in height, are set in the new fields at irregular intervals, varying from 5 to 10 feet, and without any regard for rows or symmetry. Two trees are usually set in each hole, so that if one perishes another will remain. If both grow, they are allowed to remain, each interfering with the proper development of the other. While the trees are small the soil is occasionally stirred about them with a machete and the weeds are cut down with this same instrument.

No attempt is made to control the form of the tree by pruning or to protect it from the ravages of insects and diseases by spraying or by other methods. The shade is often too dense, and no effort is made to reduce it by pruning the shade trees. This neglect results in tall, spindling, shapeless coffee trees that require from five to seven years to come into bearing. After the trees begin to bear volunteer trees spring up, many of which are allowed to grow until the groves often become a dense thicket, through which the coffee pickers pass with difficulty. Under these conditions the fruit is largely borne on the tops of the trees, which makes the gathering slow and laborious.

As a rule, too much shade is provided and it is a question if the

coffee could not be grown without shade. The trees best suited for the shading of coffee are recognized as the "Guamá, Guava, Moca, Hucare, and banana." The first two are considered superior to the others, a fact which may be attributed to their being leguminous trees and possibly furnishing nitrogen for use of the coffee trees.

Coffee is grown chiefly in the interior of the island on the mountain slopes and is confined largely to the west half of the island. The most prominent municipal coffee districts are Utuado, Las Marias, Maricao, Lares, Ciales, Adjuntas, Mayaguez, San Sebastian, Ponce, and Yauco, in the order named. These ten districts produce 60 per cent of all the coffee grown in the island. The Utuado district leads the list with about 17,000 acres and is nearly the center of the coffee area.

The soil conditions vary much from locality to locality, and even on one plantation wide differences often occur. Coffee is very susceptible to soil changes, and many large estates are in part only suited to the growing of coffee. This relation between soil and crop does not seem to have been well understood by the native planter, for many acres have been planted on lands that are poorly adapted to the growing of coffee solely because of the character of the soil. The best coffee is always found on soils of heavy texture, i. e., soils that are classed as clay loams or clay, and which continue heavy in texture to a depth or 3 or more feet. If the depth of heavy soil is 2 feet or less and is underlaid by stone, sand, or gravel the coffee becomes poorer, as the underlying coarse material comes nearer the surface. Sand or sandy loam never produces good coffee except it be nearly level and well fertilized. While the red clays are considered the best coffee lands, it is doubtful if the color has any bearing on their quality. The red indicates the presence of plenty of iron, which may be an important factor, but it is more likely to be the coincidence of the red color usually accompanying the heavy clays. The coral limestone along the north border of the mountains breaks down into a fertile soil well suited to bananas, citrus fruits, and minor crops, and when very fertile may produce good coffee, but such soils are not to be compared with the heavy red soils further inland. The dark-colored soils on the southern slope, especially those about Adjuntas and Yauco, are also excellent for coffee. It is claimed by some that the black soils produce greater yields than the red, but that the latter produces coffee of the best quality and trees of the longest life.

The coffee tree in Porto Rico is said to attain its maximum producing power at the age of about twelve years and continues in good bearing condition to the age of fifty years. Trees are reported at the age of eighty-two years only 2 to 3 inches in diameter, and in good bearing condition. Wherever the soil conditions are not favorable to the coffee trees they are badly infested by a leaf miner and affected by scale insects and fungus diseases.

The cyclone of August 8, 1899, wrought great damage to the coffee plantations. The terrific wind broke the large shade trees, which, falling across the smaller coffee trees, not only bore them to the ground but obstructed passage through the plantations and allowed the sun to beat down on foliage that had previously been very much shaded. The wind swayed the trees so furiously that many of their roots were either loosened or broken, while the deluge of water swept the surface and carried seaward vast amounts of organic matter, loose soil, and fertility, thus greatly depleting the soil. In places the deluge was so great that considerable areas of land, accompanied by the shade and coffee trees, slid from the mountain sides to the bottoms of the valleys, leaving only the bare rocks of the mountains. The sun poured into the groves onto slender trees that had always been accustomed to shade, and the effect on the foliage, the trunks, and the ground combined was very disastrous. As a result, the plantations, probably always showing much variation, are more spotted than formerly. What were formerly good trees are now, in many cases, barely alive, having only a few scattering leaves on their tops and bearing no fruit. The great damage caused the coffee lands through the violent washing and depletion of the soil has in many instances been a gain to the sugar planter. His fields are now more fertile than for years preceding the cyclone, as a result of the rich deposits of sediment which they received. The mean yield of coffee in Porto Rico is abnormally low, being about 2 quintals a cuerda, i. e., 200 pounds per acre. By the adoption of modern methods of planting and cultivation there is scarcely a doubt but that the yield can be doubled and it can probably be increased by five times, or 1,000 pounds per acre. On a basis of 1,000 pounds per acre, even at only 10 cents per pound, coffee growing should be very remunerative.

SUGGESTIONS FOR IMPROVEMENT.

Improvement of the coffee plantations will be attempted along two lines: First, the improvement of the old groves by reducing the shade, thinning and pruning the trees, and giving cultivation and fertilization; second, the adoption of a more rational system in the planting and care of young groves. That too much shade is used now is shown by the fact that the best and most productive coffee trees occur about the margin of the plantations or in open spaces where the shade is incomplete and where, for a portion of the day at least, the coffee trees enjoy the full sunlight.

The statement that coffee can probably be successfully grown in Porto Rico without shade does not mean that the shade can be all removed from the present plantations, nor that the young trees can be transferred from the shade of the old groves to the full sunlight of

new fields without practically all perishing. Such a radical change would result disastrously to the plants.

In reference to new plantations the first step should be the selection of seed with reference to the improvement of the trees. Seed should be selected from the vigorous, best-formed and most productive trees. It should then be planted in suitable seed beds provided with artificial shade which can be removed by degrees. As the young trees grow, the shade should be gradually removed as they seem able to adapt themselves to the sunlight. If the shade can be all removed without injury to the young trees they can certainly be transferred to the fields without great loss and will probably continue growing without shade. Only the vigorous and well-formed plants should be planted, and all should be planted on soils well adapted to the production of coffee. Planting should be made in conformity to some system. The trees should be set in rows, at least one way, and at a uniform distance of about 7 feet apart. If the land is steep a small terrace should be made about the tree. As good and thorough cultivation should be given as is consistent with the slope of the ground and the character of the rainfall. A high state of cultivation might permit washing of the soil and consequent damage by loss of fertility and would be worse than no cultivation. The trees should be pruned to some system in conformity to its nature of growth and the convenience of gathering the coffee. If there is a tendency to grow too tall they should be topped.

Such a system should not only make a much finer appearing plantation than the old haphazard way of doing, but the superior trees should reach a bearing age earlier and produce far more than under the old method. On the above basis an acre would contain 889 trees, which at the low estimated yield of $1\frac{1}{4}$ pounds of coffee for each, would give 1,111 pounds per acre. Such a yield in comparison with the present one of 200 pounds per acre would certainly be very satisfactory and justify the additional expenses involved by the improved method.

The above method is being tested by Mr. J. W. Van Leenhoff, of Isalina, in cooperation with the agricultural experiment station. While the indications are thus far good, no definite assertions can be made as to the success or failure of the method until the trees approach a bearing age.

If the ground needs a covering in order to prevent its washing, it is the purpose to sow some low-growing leguminous crop, keeping it cut away from the immediate vicinity of the young trees and using the cuttings for market. If the crop can not be economically used for forage it should be allowed to decay on the ground, thus increasing its fertility.

MARKET.

Low prices for coffee are responsible in part for the present depression to the industry in Porto Rico. Every effort should be made to introduce the coffee into the States on its merit under the name of "Porto Rico." The coffee is of excellent quality and when known it will undoubtedly replace a part of the fancy trade that is now supplied by Mocha and Java. This can be brought about by organization and a systematic handling of the product.

SUGAR.

The production of sugar in Porto Rico is at present in a very flourishing condition, and considerable capital from the States is being invested in lands and in the construction of large "centrals." It is estimated that the amount of export sugar for 1901 will reach 100,000 tons.

The area of land suited for the production of sugar is capable of being more than doubled, and by the introduction of better machinery for the extraction of the sugar and better methods of cultivation of the cane, it is safe to say that the output of sugar by Porto Rico will reach a maximum of about 300,000 tons annually.

Quantity and value of sugar exported from Porto Rico during each calendar year from 1887 to 1896, inclusive.[a]

Calendar year.	Quantity (pounds).	Value.	Calendar year.	Quantity (pounds).	Value.
1887	178,116,000	$5,068,000	1892	148,364,000	$3,897,000
1888	136,658,000	3,888,000	1893	94,992,000	2,481,000
1889	140,236,000	3,990,000	1894	106,724,000	3,170,000
1890	128,289,000	3,650,000	1895	132,147,000	3,906,000
1891	106,029,000	3,017,000	1896	122,946,000	3,604,000
Annual average 1887–1891	137,866,000	3,923,000	Annual average 1892–1896	121,035,000	3,484,000

[a] Table from Bulletin 13, Section of Foreign Markets, U. S. Dept. of Agriculture.

The above table shows that the heaviest exportation of sugar occurred in 1887; that it steadily decreased for a number of years thereafter, reaching a minimum of about 95,000,000 pounds in 1893, with a value of less than half that of the year 1887. The average exportations for the first five years are considerably greater than for the last five. In addition to sugar, molasses has also been exported to an average value of about $500,000 annually. At the present writing there are many old sugar estates that have been abandoned, the lands turned out to pasture, and the buildings in a state of ruins. These estates were mostly limited in extent and equipped with old machinery, which was not at all suited to carry on high-grade manufacturing of sugar. The lands were often too wet to give good results, and this, together with

Fig. 1.—Porto Rico Station—Native Plow.

Fig. 2.—Porto Rico Station—Harvesting Sugar Cane.

the poor equipment, has given rise to their abandonment. With better machinery and adequate land drainage, all of these abandoned estates will undoubtedly be again planted to sugar in the course of a few years. The abandonment of these estates has undoubtedly caused an increased activity in the production of live stock, and we find, therefore, that the value of live-stock exports has increased from $142,000 in 1895 to $852,000 for the year 1899.

The great damage caused to the coffee lands by the cyclone of August, 1899, through the excessive washing and consequent depletion of the soil fertility, was a great benefit to the sugar lands. A considerable part of the sediment carried by the deluge of water which spread over and inundated the most of the low lands was deposited there, often to a foot in depth. This rich deposit has in a great measure restored the sugar lands to their former fertility.

Notwithstanding the prosperous condition of the sugar business and the fact that its management is in a more advanced stage than that of almost any other product of the island, there is still room for great improvement in both its cultural and manufacturing aspect. (See Pl. XXXV, figs. 1 and 2.) The cane fields are usually well planted and kept comparatively free of weeds, but the cost of growing an acre of cane laid down at the mill, $40, is much greater than it should be. This price is, of course, for the first year, and includes the cost of plowing, planting, and cultivation as well as that of harvesting. It is a common practice to grow several rattoon crops, and these cost much less for production, because no plowing and planting are required. The yield from the rattoon crop, however, is less than for the first crop, and grows less and less each year. It is not uncommon to allow fields to produce four or five consecutive rattoon crops, and instances are recorded where as many as twenty have been grown. A reduction in the cost of planting and harvesting the first crop will tend to reduce the number of rattoon crops, and thereby increase the average yield. The number of rattoon crops allowable depends entirely upon the relative profit to be derived from them.

The drainage of the cane lands is often insufficient to give good results, and when good drainage is provided it is in the form of open ditches, which are expensive to keep in repair. A more rational, satisfactory, efficient, and, in the long run, cheaper method would be to underdrain the cane lands by the use of tile drains. Tile drainage once well installed would last for practically all time to come. It would do away with the annual cost for reconstruction and repairs of ditches, and, besides being more efficient in restoring to cultivation the areas formerly occupied by ditches, it would also facilitate the use of more improved machinery for cultivation. The planting season for cane extends over a considerable portion of the year. The large plant-

ing, or "grain culture" as it is called, takes place in October and the canes are harvested fifteen months later. Plantings are also made in February, March, April, and May, the canes being cut a year later. The harvesting and grinding season continues from January to June, a period of about five months. The seed cane planted for the "small culture" in February to May consists of the top two or three joints cut from the cane that is being harvested for sugar. The cane at this season of the year is said to be so ripe and dry that only these top joints are capable of producing new plants. The seed for the "grain culture" is obtained from the early plantings of the year, and in this case the whole cane is used for seed, it being so green that all joints will produce new plants.

No efforts are made toward improving the quality of cane by selection. Presumably, there are as great possibilities in improving cane as has been realized in the case of sugar beets during the past ten or fifteen years.

Two systems of planting are in vogue. On the north side of the island, where the rainfall is abundant, irrigation is not practiced and drainage is essential. There the land is plowed into ridges about 8 feet wide with deep furrows between. On each ridge two rows of cane are planted. Large, shallow holes, about 6 inches deep and 15 inches square, are made at intervals of about 2½ feet, and the pieces of seed cane placed in the bottom of them and covered with soil to the depth of about 1 inch. Usually the lower end of the cane is covered deeper and the upper end frequently not covered at all. After planting all further cultivation is done with the hoe. The weeds are cut from between the rows and hills and pulled from among the young plants. The soil is gradually worked around the young plants at each hoeing until the holes are filled nearly level with the remainder of the ridges. The number of hoeings required to keep the field free from weeds varies somewhat, but is seldom less than four. The canes stool out, and in about five months so completely shade the ground that weeds will no longer grow and no further attention is required until harvest time.

On the south side of the island, where the rainfall is scanty and where irrigation is imperative for the successful growing of cane, the land is plowed level. Furrows about 6 inches deep are run at intervals of about 4 feet, in which the cane is planted. The covering of the cane is shallow, the same as in the former method, and the cultivation largely done by hand. In irrigating the water is passed down these furrows, thus coming first in contact with the plants. This system of planting seems superior to the one practiced on the north side of the island. The furrows in which the canes are planted are more cheaply made than are the holes used for the same purpose, which are made by hand. The absence of surface ditches and the level surface of

the ground facilitates the use of machinery in cultivation, although but little is used, even on the south side of the island.

It is recommended that for all lands needing drainage it be supplied in the form of underground drains; that the land be plowed deeply with good plows and at such time that it is not too wet; that the cane be planted as a continuous row in furrows, and that a large part of the cultivation be done by using horse machinery and giving much the same cultivation that is used in the case of corn in the Mississippi Valley. By replacing much of the hand labor with improved machinery the cost of growing cane should be much reduced. In this connection careful attention should be given to the selection of healthy seed and of canes having a high sugar content.

In order to maintain good physicial and fertile conditions in the cane-growing soils they should receive judicious management. At present the lands are often plowed and hoed when too wet, and much injury done to its physicial properties. Few crops take more from the soil in the way of fertility, especially of nitrogen, than a good yield of sugar cane, and much care should be exercised to restore this loss. If necessary the lands should be given periods of rest and be planted to cowpeas or some good, suitable leguminous crop that can be plowed under, thus restoring the loss of nitrogen. The application of barnyard manure and of commercial fertilizers may be profitable if they can be secured at a cost not too great.

MANUFACTURE OF SUGAR.

For the most part the methods of manufacturing sugar in Porto Rico have been crude and wasteful. The mills are usually small and lacking in machinery of recent design and sufficient strength to extract all of the juice from the cane. The juice is usually evaporated by the open-pan system, and besides requiring more time and fuel than the vacuum system it produces only a low grade of muscovada sugar. The imperfect removal of the juice leaves the bagasse too wet to be at once burned, therefore it must be hauled away from the mill and spread out to dry, after which it is placed in sheds in order to keep it dry for fuel. Where efficient machinery is employed the juice is so completely removed that the bagasse can be at once burned. In the latter case the bagasse leaves the second press and goes directly to the furnace on a carrier, so that there is no handling of this material required. The bagasse furnishes sufficient fuel to run the entire plant.

The need of large "centrals" with improved machinery has been realized, and a general movement is on foot to organize the districts, do away with the old mills and secure new ones, by which more and better sugar can be obtained from the cane at a less cost.

TOBACCO.

Tobacco has for many years ranked third among the export crops of the island, and at the same time has supplied a comparatively large home demand. It is the exception to find a Porto Rican man who does not smoke, and many of the women, especially of the middle and lower classes, also enjoy the cigarette and cigar. The manufacture of tobacco into cigars and cigarettes is probably of far greater magnitude than the manufacture of any other single commodity on the island.

Quantity and value of tobacco exported from Porto Rico during each calendar year from 1887 to 1896, inclusive.[a]

Calendar year.	Quantity (pounds).	Value.	Calendar year.	Quantity (pounds).	Value.
1887	7,633,000	$1,089,000	1892	4,207,000	$737,000
1888	3,347,000	478,000	1893	4,208,000	774,000
1889	7,736,000	1,104,000	1894	3,370,000	619,000
1890	3,984,000	569,000	1895	3,665,000	674,000
1891	5,287,000	755,000	1896	2,220,000	408,000
Annual average, 1887–1891	5,597,000	799,000	Annual average, 1892–1896	3,534,000	642,000

[a] From Bulletin 13, Section of Foreign Markets.

The above figures for the ten years 1887–1896 show a decline in the exportation of tobacco. Previously the manufactured tobacco was practically all consumed at home, but at present there is quite an export trade with the States in cigars and cigarettes, and a larger percentage of the total product is now manufactured than formerly. While the annual amount of tobacco exported has declined, the price per pound has increased from an average of about 14 cents in 1887 to 18.4 cents in 1896.

The crops for 1900 and 1901 are in large part still on hand, a fact which tends to keep the price down and gives no incentive for increasing the acreage. The 1900 crop consisted of about 15,000 acres, which yielded only 300 to 600 pounds per acre. While tobacco of good quality is grown, yet there is a lack of skill in curing and fermenting it, and the people are in special need of instruction along these lines. The lands recognized as being best for tobacco are largely along the Rio La Plata. Of the tobacco districts, Comerio leads with an area of 2,000 acres, Camuy follows with an area of 1,039, and other important districts are Cidra, Naranjita, Yauco, Isabela, Aibonito, and Caguas, in the order named.

The preparation of the land for the seed beds usually takes place in August and September, and the seeds are planted from a month to six weeks later. The plants are transplanted to the fields in December and January, and require eighty to ninety days to come to maturity. The first crop of tobacco is therefore harvested in March or April. Suckers at once start from old stumps, and in from four to six weeks

another crop is ready to harvest. This second crop is much inferior to the first one, and is largely used for filler purposes. In many instances even a third crop is harvested, but it is very poor in quality and of little value except for cigarettes.

While some tobacco of excellent quality has been grown in Porto Rico, it is not known in United States trade. Formerly much of this class of tobacco was exported to Cuba, and part of it was undoubtedly shipped from there to the States.

Tobacco is a quick crop and one which should play an important part in giving early financial relief to the people of the island. By the introduction of improved methods it should offer good opportunities for investments and bring prompt and large returns on the capital invested.

The United States Department of Agriculture proposes to send two tobacco experts to the island to spend the greater portion of the next fiscal year in investigating the tobacco industry. They will begin with the planting of the crop and conduct experiments relating to all phases of the subject, from the beginning to the finish. These experiments will deal with the curing and fermenting of the product as well as the growing. This is an important work for the people of the island, and will begin with the next crop season.

CITRUS FRUITS.

While coffee, sugar, and tobacco are practically the only crops of export, many others are grown in a small way for home consumption. Many of these minor crops are not grown in sufficient quantities to supply the home market. Rice and potatoes, which are imported in large quantities, might well and profitably be grown to a greater extent at home. There is also great need of more diversity in the export crops. With so few crops for exportation a failure in one means a great reduction in the income of the people. The injury to the coffee industry by the cyclone of August 8, 1899, is a striking example, and illustrates the need of other export crops. The great reduction in the coffee receipts has caused untold suffering. Thousands of poor people who formerly were employed on the coffee plantations were thrown out of employment, there being nothing else for them to do. Many were supported by the coffee planters in order to tide them over until the groves should again come into bearing.

The production of citrus fruits will undoubtedly make a desirable and important addition to the export crops. Oranges, limes, and lemons are grown in a small way in nearly all parts of the island, and indicate that by the introduction of improved methods there will be a very good future for this branch of fruit culture. At present there are no groves planted with regularity, pruned, and cultivated. The trees are planted, a few here and there, about the buildings of the

plantations, and are given no particular attention. They are seedlings, and in the case of oranges represent all grades and conditions from the small sour fruits with many seeds and an abundance of rag to the large sweet fruit with little rag and few seeds. The range is from worthless fruit to that which is of excellent quality, but the latter occurs in very limited quantity. As a rule the oranges contain too much rag and too many seeds, and it is difficult to get together a uniform lot of any considerable quantity for shipment.

Two kinds of oranges are grown, the sour and the sweet. The experience thus far gained by those who are starting in the orange-growing business is that the sour one forms the best stock on which to graft improved varieties.

The growing of oranges in Porto Rico by improved methods is in the experimental stage, and it will require several years of systematic investigation to ascertain just what are the best varieties to use in planting, what are the best stocks on which to graft, how and when is the best time and methods to graft, what type of soil is best adapted to growing oranges, and many other allied questions.

If possible to do so, it would seem desirable to grow an orange that will mature earlier than do those of Florida and California, thus getting them into the early market when the price is good. Better transportation facilities are needed, but such will undoubtedly be supplied when the demand is sufficient to justify it.

There are several fungus diseases and scale insects which attack the orange trees, and it will be advisable for all that are importing stock for whatever purpose to guard against the introduction of diseases or insects not already on the island. Probably a law should be enacted providing for the inspection of all nursery stock introduced into the island, and requiring all infected material to be thoroughly fumigated. In the Tropics, where the breeding seasons are not checked by cold weather, both diseases and insect pests take on the most virulent form and especial care is required to keep them in check.

THE AGUACATE, OR ALLIGATOR PEAR.

This valuable fruit occurs in all parts of the island and is quite an important fruit for home consumption. During its season it can be bought in the markets at from 1 to 3 cents each while in the States it often sells at 50 to 75 cents per fruit. The trees are large and in a general way resemble the pear trees of the States. They occur scattered about here and there, growing in almost a wild state with no cultivation, pruning, or care. The fruits are large and pear-shaped, usually weighing from a pound to a pound and a half. When ripe the green skin, about one-eighth inch in thickness, separates freely from the fleshy pulp, which is the edible part. A large nut or seed

Fig. 1.—Porto Rico Station—Banana bearing Fruit.

Fig. 2.—Porto Rico Station—Gathering Cocoanuts.

in the interior also separates freely when the fruit is cut in half. The fruit contains about 10 per cent of oil, has a nutty flavor, and is quite nutritious. Americans are usually very fond of it. It is eaten raw in much the same way as a cantaloupe or is used in the form of a salad with a dressing.

With the present facilities it is impossible to ship the aguacate to the States without a large loss, but with better shipping facilities and a knowledge of the shipping possibilities of the fruit there should be a good future in growing aguacates for export to the States.

MANGOES.

This fruit, like the aguacate, occurs in nearly all parts of the island, but is more common and cheaper. The trees are large and sturdy, giving a very dense shade. The fruits ripen during the months of May, June, and July, and are eagerly eaten by the natives. They are kidney shaped, about the size of an apple, and when ripe have a yellow or golden color, often with a rose-colored cheek. The fruits vary much in size and quality and are susceptible of great improvement. They have a large seed or nut and the pulp surrounding it is rich and juicy. It has a flavor of turpentine, and owing to the large amount of fiber which some of them contain, some one has humorously described it as resembling a ball of yarn soaked in turpentine. There is a good opportunity of improving the quality of this fruit and creating for it a good demand in the States.

BANANAS.

Bananas grow almost spontaneously in all parts of the island but are not exported. (Pl. XXXVI, fig 1.) There are several varieties grown and they form an important part of the food of the natives. Several kinds of what are known as plantains are cooked green and used by the natives. They take the place of bread in a large measure. The red banana, the ladies' finger, the peach, and the ordinary banana of our commerce, are common and used by many. They sell in the interior very cheaply, often as low as a cent per dozen. Many bananas are grown as coffee shade, and in such localities the fruit often goes to waste or is used as pig feed. For its best development the banana requires a sheltered locality and moist atmosphere. Where strong winds prevail the leaves become riddled and fail to perform their functions. The best bananas in the island are in the interior among the mountains and in other sheltered localities.

There is no reason why the banana should not be greatly improved by selection and proper cultivation, and be made an important factor among the export tropical fruits. (Plate XXXVII, fig. 2.)

GUAVA.

The guava grows wild and often takes possession of the pastures. It is manufactured into jelly and a paste, both of superior quality and flavor, which command good prices in the States. The guava is a bush, and the fruits ripen in August, September, and October. They are relished by the cattle, and the numerous seeds being small and hard, are not digested but are scattered about the fields and thus distributed.

This fruit, by selection, pruning, and cultivation, can undoubtedly be greatly improved in quality and productivity. It is one of the fruits for which there is already an established demand, and one which can be manufactured at home, thus giving employment to many, and at the same time not requiring any transportation facilities other than those now in operation.

PINEAPPLES.

Pineapples of fine size and excellent quality are grown in many parts of the island. They do best on the sandy lands about the coast or on the stony hill lands of the interior. They require good drainage.

There are three principal varieties now grown: "Pan de azucar" (literally, sugar loaf), "Carbezona" or "Porto Rican," and "smooth cayenne." The first named is the sweetest but usually contains much fiber, the second has a white meat, is subacid, and of pleasant flavor. It is large and comparatively free from fiber. The third was probably introduced from Florida but is not much grown.

Pineapples are but little exported, but with proper facilities might well become an important export crop. By the introduction of the right sorts for canning purposes a cannery might be started and do a good and profitable business.

COCOANUTS.

Cocoanut palms grow best on the coral sands bordering the coast, but often occur in the interior. (Pl. XXXVI, fig. 2.) Those in the interior, however, do not bear so early nor so well. The coast conditions, which combine a level, wet, sandy soil with the salt-laden atmosphere, seem to be the typical conditions for the production of nuts. The trees are easily grown, and require but little care in the way of cultivation. They begin to bear in from 5 to 7 years, and at 10 or 12 years of age often produce as many as 200 nuts per tree annually. (Pl. XXXVII, fig. 1.) The nuts are much used for home consumption by the natives for "cocoa de agua," and are exported to the valuation of about $10,000 annually. The cocoanut lands are limited in extent, and might be used for the combined purpose of growing pineapples and nuts.

FIG. 1.—PORTO RICO STATION—COCOANUT GROVE.

FIG. 2.—PORTO RICO STATION—MARKETING BANANAS.

CACAO.

The requirements of cacao are so similar to those of coffee that it should do well on the island. Plants of it are found here and there, and, as a rule, are doing well. It may become an import crop in the course of a few years.

FIBER PLANTS.

The two principal fiber plants are the maguey and the emajagua. The former is a species of agave, or century plant, and the leaves often attain a length of 8 or more feet. When blooming it sends up a flower stalk to a height of 30 feet or more. The fiber is much used in the making of rope, belts, hammocks, etc. The latter is a shrub and the fiber part is the inner portion of the bark. It is much used for making coarse ropes and baskets. There are other fiber plants on the island which are not much used, and it seems very likely that the abaca, a species of banana from which the manila hemp is obtained, would thrive and become a profitable crop for the island.

Twenty or more years ago some cotton was grown on the island, and remnants of it still remain in the form of occasional small cotton trees. During the past year a certain cotton company in the States has been experimenting with cotton in various parts of the island. They have planted every month in the year and have arrived at favorable conclusions, but have not made public the results of their investi gation. My personal observation leads me to believe that the best season to plant is June or July, thus having the cotton mature in the early part of the dry season, which usually begins with December. The beginning of the dry season, however, is rather uncertain, and may be delayed by weeks or even months.

There are many other plants of economic value, some of which are native and others which might be introduced that would be valuable crops for the people of the island, but space will not be taken for further mention of crops.

MINOR CROPS.

Minor crops, such as rice, corn, potatoes, yams, beans, peas, tomatoes, melons, and a variety of other vegetables, are grown in a limited way for home consumption. There is room for great improvement with practically all of these crops. Just where the trouble now lies is difficult to say. Little seems to be known in regard to the time and manner of planting. In the markets one finds quite a variety in the line of vegetables, but practically all are of very inferior quality. Tomatoes are very small and wrinkly, and in the States would be thrown away. Potatoes grown here are small, and must be imported

to the value of about $400,000 annually in order to supply home needs. Onions are also imported, as indeed are quite a variety of vegetables. Rice is the heaviest import, and amounts to considerably more than $1,000,000 annually. Many small patches of rice are grown in the interior of the island on the hillsides, but none is grown on the lowlands about the coast. There is considerable low, swampy land about the coast that might be devoted to the growing of lowland rice. The time of seeding and manner of cultivating would, of course, have to be determined by experimenting, but much knowledge could be obtained from Louisiana, where rice is grown on an extensive scale. Many of the methods used there would no doubt be applicable to Porto Rico.

Corn is grown to a considerable extent, and is used as food for both man and beast. The variety grown is a smooth flint, very similar to that grown in the New England States. It is shelled and ground, as a rule, by hand, although a few use hand shellers and grinding mills.

Wheat, barley, and oats are practically unknown, so that corn forms the chief grain that is fed to animals. Very few of the horses are fed any grain, and practically no grain is given to the cattle or work oxen.

FORESTRY.

It is said that Porto Rico was once covered with a beautiful virgin forest. Only a few remnants of such forest now remain to indicate what were the former conditions. It would seem advisable to protect and preserve these remnants, and in some instances to plant new forests.

AGRICULTURAL MACHINERY.

Very little agricultural machinery is used. In the cane fields plows, harrows, carts, hoes, spades, and machetes constitute nearly the complete list, while in the coffee district the hoe and machete are about the only implement used. In the latter case the steepness of the hills prohibits the use of much horse machinery, but in the cane fields modern plows, harrows, and cultivators can and should be used.

LIVE STOCK.

The live stock of Porto Rico consists mainly of cattle and horses, together with a small number of mules, asses, swine, sheep, and goats. Following is the total number of each class as ascertained by the census of 1899: Cattle, 260,125; horses, 58,664; mules, 6,985; asses, 1,085; swine, 66,180; goats, 15,991; sheep, 6,363; and fowls, 265,499.

Of the total number of cattle, 28 per cent are given as milch cows and 22 per cent as work oxen, the remainder being classed as calves, steers, bulls, young bulls, heifers, and yearlings. Of the various districts Bayamon leads in all classes of cattle except oxen, in which Ponce

excels. Ponce has more oxen, mules, and asses than any other district because of the demand for them as work animals on the large sugar estates.

The horses of Porto Rico are very small, and, as a rule, are poorly cared for and driven or ridden with very poor judgment. There are some exceptions, however, with regards the treatment of horses, and I have seen some very fine and spirited animals that were kept in the pink of condition. The feed of the horses consists almost entirely of cut grass, it being very exceptional to find them fed on grain. Such bulky food necessarily distends the bowels and unfits a horse for rapid traveling. Notwithstanding the fact, however, the native Porto Rican will harness his team to the carriage when their stomachs are full, and start at once on his journey at a full gallop. Under such circumstances the horses are winded at the end of the first kilometer, and before the second one is completed they are covered with sweat and lather, and wholly unfit to continue at anything but a slow gait unless given a rest. They are forced to continue, however, and complete the journey under continual lashing by the driver. When long journeys are to be taken frequent relays are made, usually at each 10 to 15 kilometers.

Although small the better horses are of good form, clean of limb, and apparently have a strain of good blood. With proper care as to feed and methods of driving these little horses are capable of rendering good service. As saddle-horses they are particularly good and easy-gaited and as hill climbers they are unexcelled and very sure-footed.

There is no marked mortality among the horses due to disease. The common diseases due to mistreatment, such as colic, lung fever, etc., are met with, but the worst, most revolting, and dangerous disease is glanders. Glanders is present in all parts of the island, and drastic measures should be taken at once to stamp it out. A skin disease, probably a form of mange, is not uncommon. Comparatively speaking, the insects that trouble the horses are few. Ticks are quite numerous, but there are practically no flies to bother.

The cattle of the island are better than one would expect to find. As work oxen they are excellent. Bullocks weighing 12 to 13 hundredweight, with powerful necks and good forms are not uncommon. Steers range on the luxuriant pastures of Guinea grass and "malojillo" grass and become fat enough for market without the addition of any other feed. Besides supplying the home demand for fresh beef the exportations of live cattle as beef and work cattle amount at present to more than half a million dollars annually. The chief market for the cattle is Cuba. In milking qualities the cattle fall far below their standard for beef and for work. The flow of milk is small and the quality poor as regards its fat content. It is quite the custom to milk the cows while the calf is sucking; otherwise it is thought they will

give but little and soon go dry. Milk sells in the towns and cities from 6 to 9 cents per quart. The more advanced dairyman delivers the milk in cans hauled on a spring cart, while others carry it to market in small cans on the backs of horses. Still others drive the cow about from door to door and milk directly into the customers' receptacles A form of cheese is made which resembles our cottage cheese, but is in reality more solid. Practically no butter is made, and indeed butter is but little used by the people of the island. Cattle enjoy much comfort in the island, suffer little from the heat, are quite free from the annoyance of noxious insects, and are seldom bothered by diseases. They range on luxuriant pastures and seldom want for abundance to eat and drink. Export cattle for beef sell for $2.25 per arroba (25 pounds). This is discounted 40 per cent for shrinkage in dressing, which makes the price about $5.40 per 100 pounds, corresponding very nearly with the prices in the United States. In recent years the price has been as high as $3 per arroba, which equals $7.20 per 100 pounds. The raising of live stock in Porto Rico may be considered a paying business as conducted for the past few years. The demand for some of the present pasture lands for the production of sugar will have a tendency to increase the cost of production.

The swine of the island are of a very inferior kind, being small and of the "razor-back," "rail-splitting" variety. They are commonly tethered out by a rope and get their living largely from grass and weeds, but are at times allowed to range in the tuber patches, where they can root up the yams, potatoes, etc., and they are also fed plantains and the small nuts that grow on the royal palms.

Goats are of the short-haired, milk-producing kind and are used for flesh and milk. They apparently do well.

Sheep are rather scarce and have comparatively little wool. It is probable that sheep for the production of wool would not do well in so warm and wet a climate.

Fowls, which consist chiefly of chickens, are small and active, the cocks being of the kind used for fighting. Eggs in the markets can seldom be purchased for less than 2 cents each, and chickens are as correspondingly high in price.

There is room for improvement all along the line of live stock, the demand being greatest in the case of the milch cows, horses, swine, and chickens. The essentials in such improvements will be the introduction of new blood, care in selection, and more rational methods in the feeding, care, and treatment of the animals.

INSECT PESTS.

Of the insect pests nothing is more pernicious than a mole cricket, known as "la changa." It is believed to have been introduced from Peru, and is very destructive to a wide range of plants in their early

growth or period of becoming established. It is especially troublesome in starting vegetables on sandy land. It works at night, burrowing beneath the surface of the ground and eating the young plants off just below the crown. In case of a lack of food it migrates during the night, even to a considerable distance, and continues its destructive work. On account of its nocturnal habits, its mode of flight, and working beneath the surface, it is a most formidable pest, and no doubt much patience, time, and ingenuity will be required to exterminate it. Methods of extermination by means of barriers of tar, by catching with traps, light, and by the use of fertilizers have already been inaugurated, but it is yet too early to know what ultimate success may be attained.

Scale insects, especially the purple scale and the chaff scale, are common on the orange, as are also several fungus diseases, among which may be mentioned verrucosis, melanose, and sphærostilbe. In the interest of the orange planters these need immediate attention, which will be given as soon as the entomologist can spare the time.

THE SCOPE AND PURPOSE OF THE IRRIGATION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

By Elwood Mead, *Irrigation Expert in Charge.*

With relation to rainfall the territory of the United States is divided into three parts—the humid, the subhumid, and the arid. In the humid region the rainfall is ordinarily abundant, but there are occasional seasons when it is insufficient for the raising of crops, and in most seasons there are times when crops are checked in their growth by periods of drought lasting from a few days to a few weeks. The subhumid region includes the territory where dry periods in summer are the rule. The injury to crops in subhumid regions is due to two causes—insufficient moisture and great irregularity in its distribution. The arid region includes the areas where cultivated crops can not be grown by the aid of rainfall alone.

Geographically, these regions are arranged from east to west, although no exact line can be drawn separating them. The humid region, as generally described, includes all of the United States westward to a line which would cross Nebraska and Kansas about halfway between their eastern and western borders. The subhumid region lies between the humid and arid regions, extending from the Gulf of Mexico to Canada and including irregular areas in the different Pacific coast States; while the arid region includes all the territory lying west of the eastern subhumid belt with a considerable exception along the Pacific coast, and with smaller local areas in each of the arid States.

Irrigation is employed as an aid to agriculture in all of these regions. It is a necessity in the arid region, of great value in the subhumid district, and is proving highly profitable in the growing of certain crops in the humid region. There are also large areas in the recently acquired insular possessions of the United States where irrigation is required, and where the value of the products permits of a large outlay to provide for its use. The work of the irrigation investigation of the Office of Experiment Stations covers therefore the whole of the United States.

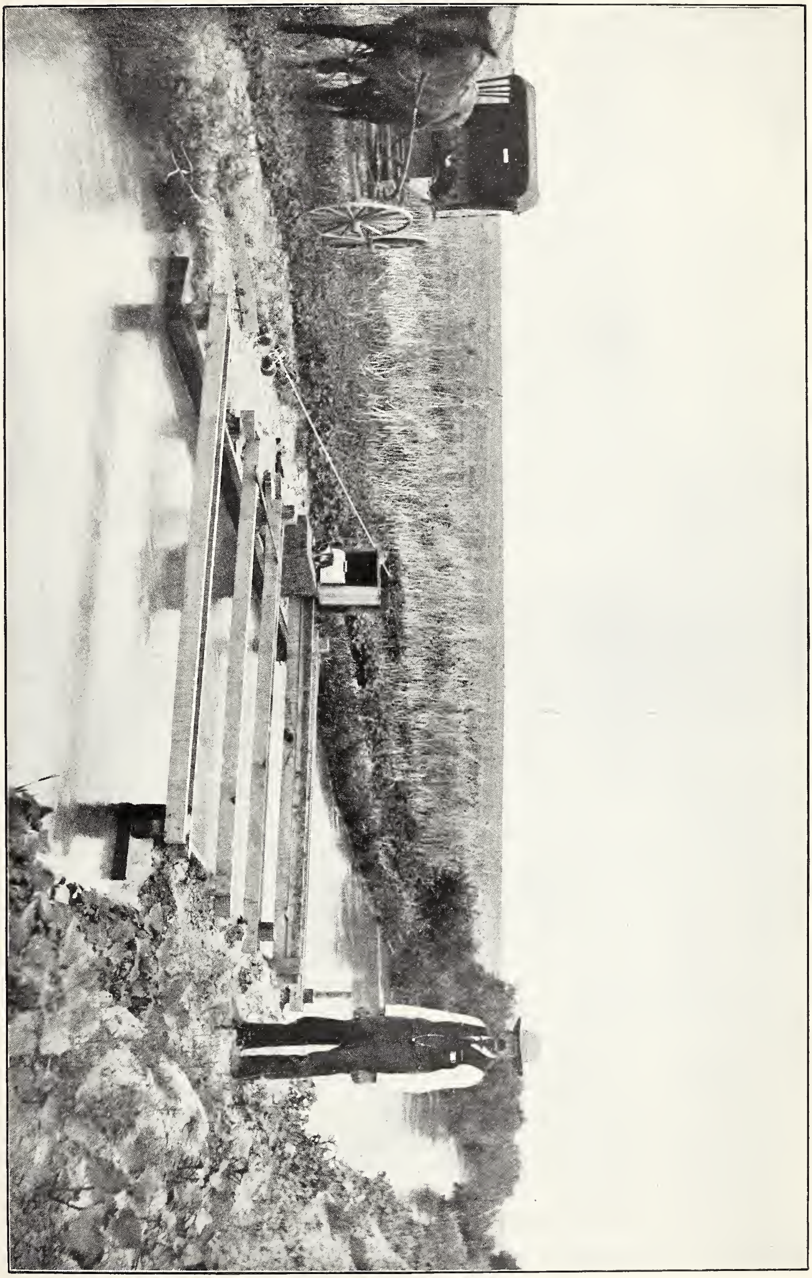
INVESTIGATIONS IN THE ARID REGION.

The greater part of the irrigation work of this Office has been carried on in the region where farming is impossible without the artificial

application of water to crops. This includes all of the Territories of Arizona and New Mexico, the States of Colorado, Utah, Nevada, Montana, and Wyoming, and large parts of California, Oregon, Washington, Idaho, North Dakota, South Dakota, Nebraska, Kansas, and Texas. The greater attention paid to the problems of this section of the country is justified by the fact that here irrigation is a necessity rather than a valuable adjunct to agriculture. It measures agricultural settlement and very largely controls the development of other industries, because both the cost and comfort of living are very largely determined by the production of a home food supply. In the regions farther east, the adoption of irrigation is determined by whether or not it will improve conditions already favorable, but in the arid region it is the choice between civilization and desert condition.

The work in this region has followed two general lines—agricultural and engineering, legal and social. Of these, the legal and social problems present the greatest difficulties and stand most in need of an early solution. The success of irrigated agriculture in this region requires first of all the creation of institutions which shall offer a just and adequate foundation for future development. Such a foundation requires that the users' rights to streams must be clearly defined in order that those who now use streams and those who expect to use them may understand how much of the water supply is appropriated and how much remains open to appropriation. The litigation and controversy which now menace communities and which are a constant source of anxiety and loss to irrigators should be brought to an end. In order to effect these desirable reforms, a knowledge of certain essential facts is required. Among these are the quantity of water required to grow crops, the losses from seepage and evaporation in distribution, the character of the control over streams already vested, and the kind of administrative measures needed to insure effective division of streams among the multitude of users who depend thereon. Specific information along these lines is indispensable to wise and effective action in the future either by the Government or by individuals. It is the information which should have been gathered at the very outset of this development, but the long delay in its collection renders it all the more urgent that it be carried on now to an early and effective completion.

The work along agricultural and engineering lines has been largely carried out in cooperation with the agricultural experiment stations of the different States, and with the State engineers in States having such officials. By undertaking systematic work on some of the general problems of irrigation, this Office has been able to supplement and extend the work of the experiment stations, and at the same time has aided them to take hold of other studies, such as problems relating to the economical use of water on different crops. It makes possible the



IRRIGATION INVESTIGATIONS—MEASURING STATION ON JACKSON LATERAL, LAGUNA CANAL, ROCKYFORD, COLO.

bringing together of observations from the whole country. It promotes uniformity of methods in these investigations and thus gives to the results a wider value than is possible with each station working independently and alone. It brings together the experience of the whole irrigated West for the use of each locality, and shows the farmers of one section where their practices can be improved by adopting those of other and oftentimes far distant sections.

AGRICULTURAL AND ENGINEERING PROBLEMS.

The studies of the practical questions involved in diverting water from streams, transporting it through canals and ditches, distributing it over the land, and determining the requirements of different crops have been carried on in all of the arid and semiarid States with one exception. In general, the results of this work show that the losses in distribution are much greater than has usually been supposed, and that the quantity of water required, where these losses are included, is somewhat greater than has been estimated by many writers on the subject or stipulated in many water-right contracts. The stations for the measurement of the duty of water are scattered over nearly one-third of the United States. The averages of the different measurements for the past two years show a surprisingly close agreement when this wide range of conditions is considered, as appears from the following summary:

	Feet.
The average depth of water applied to crops in 1899 was	4.35
The average depth of water applied to crops in 1900 was	4.13

One of the results of this work has been to show the importance of keeping canals in good condition, and to emphasize the benefits resulting from diminishing as far as possible the losses by percolation. Measurements show that the loss from seepage and evaporation in ditches and canals varies from 15 to 70 per cent of all the water taken in at their heads, and that by far the greater part of this loss is due to seepage. Formerly many believed that most of the loss was due to evaporation, and was therefore beyond the power of man to remedy. Now that it has been demonstrated that the water disappears through the sides and bottoms of ditches and canals, steps can be taken to improve these channels and the loss stopped to a great extent. Improvements of this character will increase the area which can be irrigated, and save much land for productive agriculture which would otherwise become swamps and marshes.

The difference between the high and low duties obtained under practically the same conditions shows that where water can be had in abundance the natural tendency is to use too much, resulting in a reduction in the yield of crops, a temporary injury to the land, and a

limitation of the area which can be irrigated with the available water supply.

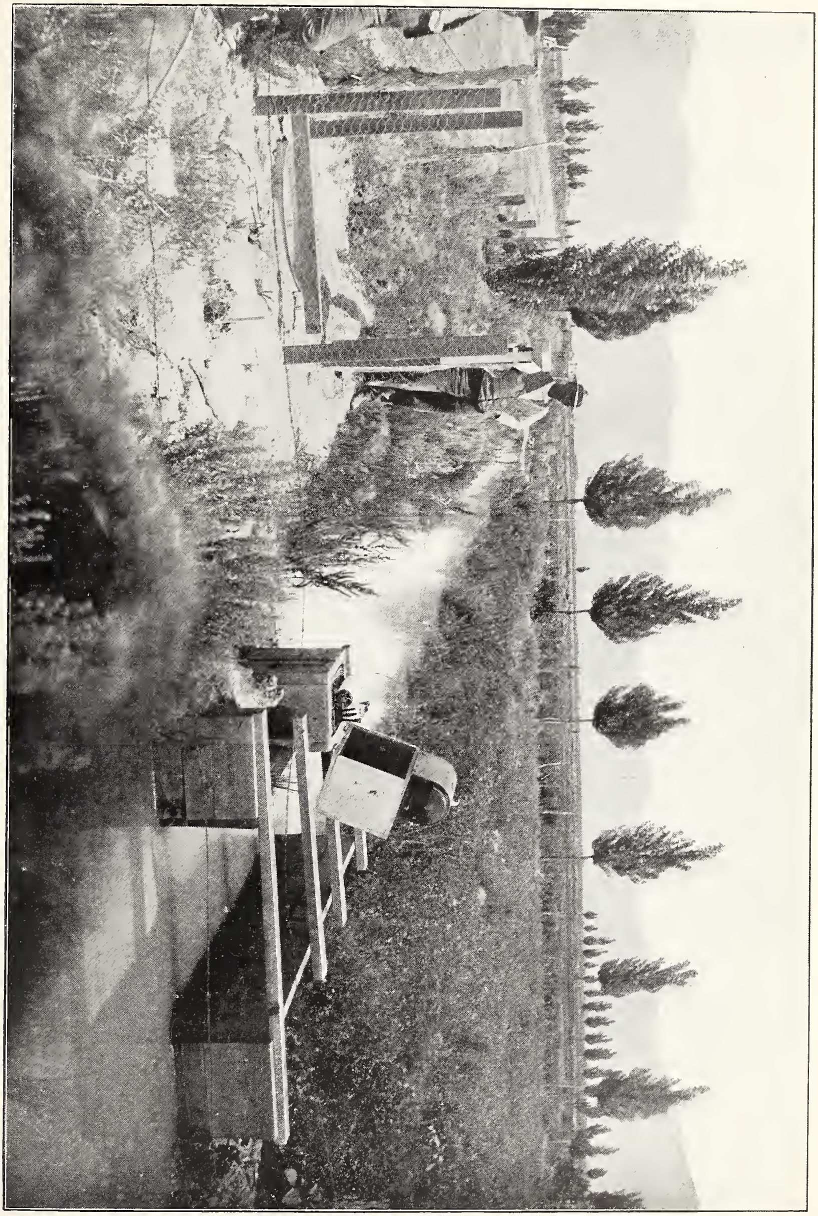
In many localities a lavish use of water has converted areas once arid into alkali marshes, of which the only product is cat-tail flags, and made drainage necessary at a cost fully as great as was required to provide the water supply in the first instance. The need of this drainage might have been avoided in many cases had canals been constructed with more care and the evil results of overirrigation appreciated at the outset,

The soils of the arid region are rich in mineral ingredients. This is due in part to their origin and in part to the scanty rainfall, which has not been sufficient to wash out the soluble elements, as has been the case in humid regions. Because of this there are large areas which are highly charged with alkali. The tendency of irrigation is to leach these salts out of the higher grounds and concentrate them in the lower lands. Evaporation tends to bring them to the surface, where they accumulate in such quantities as to kill vegetation. The remedy is to be found in drainage, and this investigation has been called upon to assist in solving the larger engineering and legal problems connected with the formation of drainage plans. As some of these districts embrace in the aggregate many thousands of acres, in which not only the alkali but the water plane has risen until it has reached the surface, it is necessary that the plans should be comprehensive, and must include provision for removing the surplus water as well as the salts which are to pass with it. Drainage studies must include the causes of their being flooded and a determination of the source and volume of the water to be removed. Drainage and irrigation are a part of one whole, and their investigation should be carried on together. The office is now engaged in this work in Colorado and California.

The publication and circulation of the facts being gathered regarding the injuries resulting from excessive losses in distribution or wasteful use will go far to prevent a recurrence of such injuries in other localities where irrigation is yet in its infancy. Another result will be the reclamation of more land than would otherwise be possible.

INSTRUMENTS FOR MEASURING WATER.

In carrying on the measurements of water it was found that the instruments used were in many cases not suited to the work required of them, and were so expensive as to limit their use generally to Government and State work. With the progress of the work of the investigation there has been a growing demand for instruments which will do accurate work and at the same time be within the reach of canal companies and individual irrigators. The instruments most used are the current meter and the register for keeping a continuous record



IRRIGATION INVESTIGATIONS—FLUME AND REGISTER USED IN MEASURING IRRIGATION WATER.

of depth of water at any point. Efforts have been made to cheapen these instruments and at the same time increase their efficiency. Little has been accomplished with the current meter, but the water register has been so simplified as to reduce its cost by more than half without any sacrifice in accuracy. The appearance and method of using these registers is shown in Pl. XXXIX.

LEGAL AND SOCIAL PROBLEMS.

The measurements made to determine the quantities of water used and the losses from canals has another object besides the improvement of agricultural practices. It is a principle of irrigation law, in theory at least, that rights to water are based on beneficial use; that is, a person or company can maintain a right to only so much water as he or it can put to a beneficial use in irrigation. It is of first importance, therefore, to know how much water is needed to grow crops on a given area, in order that courts and boards of control may intelligently determine the amount of rights to water, and officers charged with this duty be able to prevent wasteful use by those who have early rights or a desire to monopolize the supply. Because of the lack of this information, rights to water have too often been established without any regard to the volume of the stream, the capacity of canals, or the needs of the land to be irrigated. The attempt to utilize such excess rights can lead to nothing else than continued litigation and trouble. The facts gathered in these investigations are already being eagerly sought as a guide in the establishment of water titles, and they are certain to prove one of the most effective agencies in preventing erroneous or excess decrees in the future.

A knowledge of the extent of the losses from canals is also necessary to the proper distribution of the supply. Appropriations usually contemplate the measurement of the volume allowed at the head of the canal, hence the amount granted should be great enough to meet all the necessities of crops and also to allow for losses in transit. If this estimated loss is too large the volume taken in at the head gate will be greater than the needs of the land irrigated, but if too small irrigators will suffer. Excessive allowance for these losses puts a premium on poor construction, hence data is needed to show what are reasonable losses and to prevent anything above this. Where losses can be stopped appropriations should be cut down in order to compel ditch owners to make them economical water carriers. Losses which can not be stopped should be provided for.

IRRIGATION LAWS.

Along with the observations and experiments in the use of water has gone a study of the laws and customs which control its distribution. This study reveals the fact that the development of irrigation

law has not kept pace with irrigation engineering or agricultural practices. As the need and value of water has increased, engineers and farmers have found ways to conserve the supply and economize in its use. But it is too often the case that this increase in value has only added to the uncertainty as to titles, since it presents greater inducements or temptations to those holding inferior rights to try to secure a larger share of the supply. The absence of tribunals for the final establishment of water titles, and the lack of public control over the division of streams, puts upon the holders of the older and better rights the burden of protecting their interests either by force or in the courts. The greatest need of irrigation is legislation which will end this uncertainty and controversy, but from the nature of things such legislation is hard to secure. Conservative legislative bodies are slow to act, and they often have not the information on which to base intelligent action, even if they have the desire to do all that should be done. The conflicting views of appropriators of water make it impossible to enact any effective law which will not be strongly opposed, or which will not work hardship to some individual. The work of this Office is limited to collecting and publishing information, with discussions by experts whose broad views enable them to better interpret the facts than is possible where details and local interests obscure the general policies which should prevail.

Studies of irrigation laws and customs have been made in connection with the measurements of water in all the arid States and Territories. Comprehensive studies of irrigation laws and customs have been made in California and Utah. A report dealing with the agricultural situation in California has just been published. This study was undertaken in response to a petition from the citizens of that State in the hope that a clear statement of existing conditions would help toward the enactment of a comprehensive code of irrigation laws.

A similar study has been made in Utah, and the reports of the different observers are about ready for publication. These reports will show that titles to water in that State are far from being stable or secure, and that there is urgent need of a cheaper and simpler method by which they can be permanently settled.

The conditions found in California and Utah are not peculiar to those States. They are common to nearly all the arid States. Their betterment is the first step in the successful or the complete use of Western water supplies. As has been said, the work of this Office can not extend to the enactment of laws. It must stop with showing existing conditions and pointing out remedies for the evils found. With this end in view the laws of not only our own States, but of Canada, Australia, Europe, and Egypt, are being studied in order that the best lessons from the experience of all the world may be within the reach of those who must enact the laws which will protect and

encourage investment in irrigation enterprises. An agent of the Department is now in Egypt studying the legal systems in vogue there.

ORGANIZATION OF IRRIGATION INDUSTRIES.

Not less important than the system of irrigation laws is the character of the organizations which control the water supply under these laws. Irrigation is essentially a cooperative industry. In its beginning small ditches were sometimes constructed by individual farmers, but opportunities for such construction are practically all utilized. The large canal covering the lands of many farmers is in most remaining cases the only possible one; hence the existence of the industry calls for organization and cooperation, and in most cases not only cooperation of farmers but of capitalists as well. The problem to be solved here is how to secure returns upon the capital invested and at the same time keep the land and water within the reach of the poor man, the only man who is seeking for a new home. This problem has not been solved in this country. It is one which must be solved before irrigation can go much further.

Under the laws of many States water rights are granted to the canal companies. In those States the rights of the farmers depend on the form of the organization of these companies rather than on the laws. The reports of this Office show that the peace and prosperity of many communities, as well as the economy with which water is used, depend almost wholly on the rights of the individuals under the companies. This study of organization and its effect on development is being carried on wherever the measurements of water have been made.

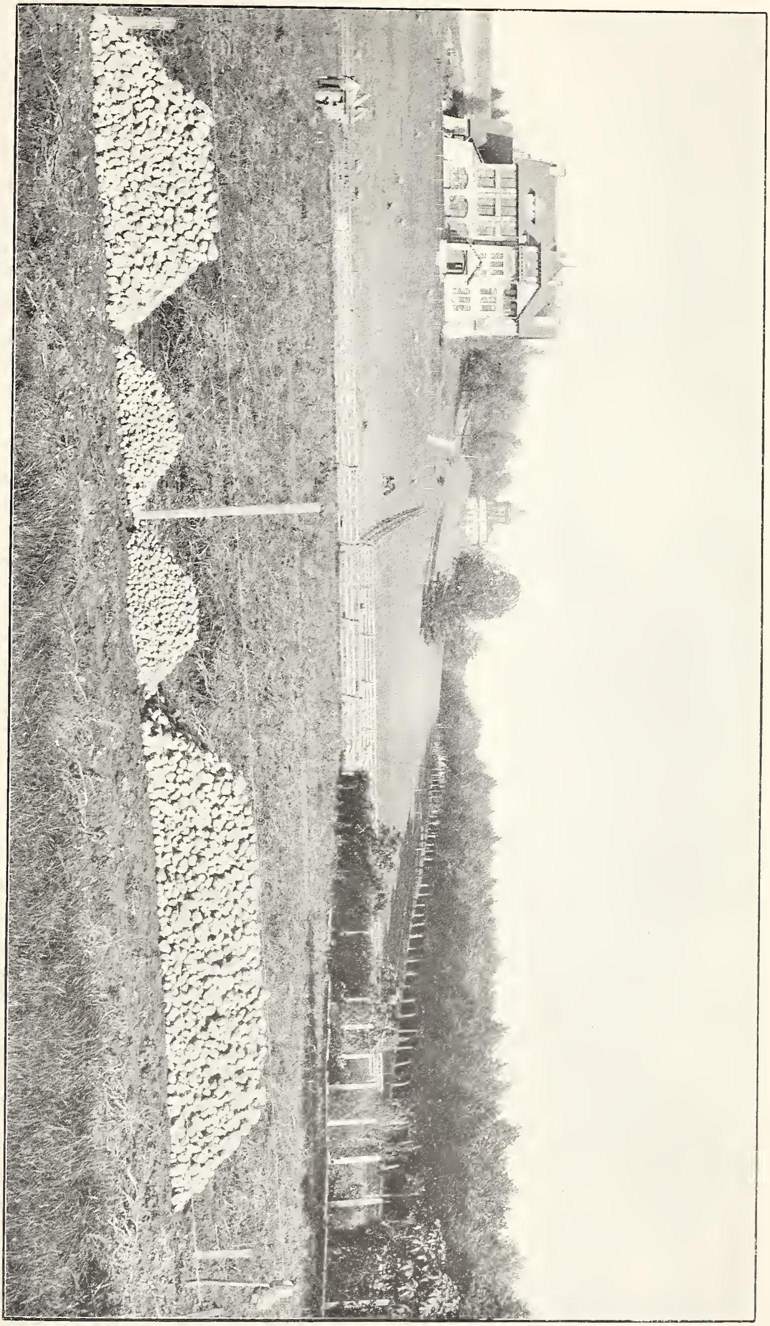
In this connection it seems proper to reiterate the views expressed in a former report on the subject of water rights. The first step in future development should be to reach an enlightened agreement regarding the true character of these rights. The idea of private ownership in water apart from land can not prevail without creating institutions essentially feudal in character. To give to companies or individuals the control of streams, and make the farmers who use those streams dependent for their rights on the conditions which these companies impose in private contracts, is to make the water company the practical owner of the land it serves and the irrigator and farmer a tenant. A proposition which would contemplate turning over all the land of the West to private monopolies and making those who have homes upon it dependent upon these monopolies would not command popular support, but the idea of private ownership in water, amounting to a virtual monopoly of this vital element, has been permitted to grow up in some sections of the West. To a certain extent it has obtained recognition in legislation and protection in judicial decrees and decisions. Such a doctrine meets with no favor in other irrigated

lands, and should in this country give place to the more just conception that rights to water should be restricted to the right of use, and that ownership should not be vested in either companies or individuals, but in the land itself. When this principle is adopted the control of water is divided like the control of land among a multitude of proprietors; water monopoly is impossible, and no other abuse or injustice is encouraged. Years of experience in other lands and the limited experience of this country have abundantly proven that peaceful and orderly development can not be realized except as water and land are united in one ownership, and canals treated as public or semipublic utilities rather than as a means of fastening a vicious monopoly upon communities.

IRRIGATION IN THE SUBHUMID PORTIONS OF THE UNITED STATES.

The subhumid portions of the United States possess certain advantages in the employment of irrigation which must in time greatly extend its application in this section of the country. There is a greater rainfall and a more humid atmosphere than in the arid region, so that a given water supply and a canal of given dimensions will irrigate more acres than in the region wholly arid. Much of the subhumid district east of the Rocky Mountains is remarkably well suited to the distribution of water in irrigation. The slope of the country away from the mountains is about what is needed for the construction of canals and the distribution of water over the ground. The practical obstacles to be encountered, either of an engineering or agricultural character, are less, as a rule, than in either the arid or humid sections, and the cost of supplying water is proportionately reduced. Important studies have been made during the past year in this region by Prof. O. V. P. Stout, of the Agricultural Experiment Station of the University of Nebraska, acting under the direction of this Office. This station is in a section where lands have been cultivated for many years, and where agriculture is a demonstrated success without the aid of irrigation. The question to be settled is whether the use of water on general farm crops will give sufficiently increased yields to repay with a profit the cost of providing the water supply and distributing it over the land. Results thus far secured show that it will. The maximum yield of corn in this locality without irrigation is about *40 bushels per acre*, while the lands irrigated during the past year yielded *from 40 to 60 bushels per acre*, with a maximum yield in rare instances of *90 bushels per acre.* Two adjacent fields, one irrigated and one depending on rainfall alone, *yielded 66 bushels and 20 bushels per acre*, respectively.

The methods of diverting and applying water were those of the ordinary irrigator; the soil and climate were typical of the terri-



IRRIGATION INVESTIGATIONS—RESULTS OF IRRIGATION IN WISCONSIN.

The two central piles show the yield and size of potatoes grown on unirrigated rows. The two end piles show the yield and size of potatoes grown on irrigated rows.

tory which extends westward from the Missouri River for 250 miles, and the results can fairly be taken as representing what may be expected in seasons of scanty rainfall throughout the greater part of the subhumid district.

IRRIGATION IN THE HUMID PORTIONS OF THE UNITED STATES.

The experience thus far gained makes it certain that irrigation is destined to be an important means of improving the already prosperous conditions of agriculture in humid and subhumid portions of the United States. The possibilities along this line have not yet been fully established, but the lessons thus far learned seem to be that it has a wide field of usefulness wherever intensive agriculture is practiced or where insurance from drought is important. The irrigation investigations of this Office now include a study of the problems of irrigation in this region—in Wisconsin and Missouri, to determine what can be done in the States of the Middle West; in New Jersey, to ascertain its field of usefulness in the North Atlantic States; in the Carolinas and Georgia, to determine its possibilities in the South Atlantic region; and in Louisana and Texas, in connection with the increasing use of irrigation in the production of rice.

IRRIGATION IN THE MIDDLE WEST.

During the past season studies of the benefits of irrigation in Wisconsin have been carried on under the immediate direction of Prof. F. H. King, of the College of Agriculture of the University of Wisconsin, at the station farm at Madison and at Stevens Point. In both cases the water supply had to be provided by pumping, and records have been kept to show the amount of water used, the time of its application, the cost of pumping, and the increase in yield of the various crops to which it was applied. Owing to the exceptional drought which prevailed, the results were highly favorable to irrigation. The difference in the yield and size between the irrigated and unirrigated potatoes is shown graphically in the illustration (Pl. XL), in which the larger piles of larger potatoes represent the product of the irrigated rows and the smaller piles of smaller potatoes the unirrigated rows. If the results of one season's trial would justify drawing definite conclusions, it would be that irrigation in Wisconsin is a marked success; but that is not the case, and it is the intention to continue these studies for a number of years, the work being broadened so as to include all the crops which promise beneficial results.

A cooperative investigation in irrigation is also being carried on between the Missouri Experiment Station and this Office at Columbia, Mo., under the direction of Prof. H. J. Waters. Apples, strawberries, and nursery stock were the crops receiving the most attention, arrange-

ments for the water supply not having been completed in time to prepare for its application to other staple farm crops. The beneficial effects of the irrigation of strawberries are shown in the illustration of the irrigated and unirrigated rows (Pl. XLI, figs. 1 and 2). Careful records were kept of the quantity of water used, the cost of furnishing it, and the time of its application. The report of Professor Waters states that "the season was very disastrous to strawberry plants, many of the old plants dying, and practically no runners being formed under ordinary treatment. The irrigated plants developed strong crowns, and undoubtedly stored an abundant supply of food for next year's crop. The strawberry nurseryman, the man whose business it is to supply plants for the commercial strawberry grower, will find in irrigation absolute protection against failure." It will require next year's record of the yield to determine the full measure of the benefits of this year's irrigation. Referring to the result of this year's watering of nursery stock, Professor Waters believes that nurserymen will find irrigation exceedingly profitable, that it will result in securing larger growth in young trees, trees with better formed heads, and possibly a saving of one year in the time when nursery stock can be placed on the market. He also believes that the protection of bearing trees from injury by drought is a matter of very great importance, because this injury often extends beyond the season when the scarcity of water begins.

IRRIGATION IN THE NORTH ATLANTIC STATES.

In the North Atlantic States the large area devoted to market gardens makes security against drought a matter of much importance. Throughout this region the average rainfall provides sufficient moisture if properly distributed, but short droughts just at the time when the crops are maturing frequently cause heavy losses. In many years no such droughts occur, but they come often enough to make the growing of vegetables and small fruits uncertain. The problem to be solved is whether the saving of an occasional crop and the increased yield of many crops will repay with a profit the cost of providing a water supply. The study of these questions is being carried on by this Office in connection with the agricultural experiment station in New Jersey, Prof. E. B. Voorhees, director of this station, being in charge. His experiments, so far reported, have been limited to small fruits. They show that, in case of almost all varieties, the increase in the product of the irrigated tracts over the unirrigated ones was considerably more than enough to pay in a single season the entire cost of providing the water supply as well as the expense of applying it.

In addition to making experiments with small fruits, Professor

FIG. 1.—IRRIGATION INVESTIGATIONS—RESULTS OF IRRIGATION IN MISSOURI.

Showing growth of strawberry plants on the unirrigated plat at the close of the season.

FIG. 2.—IRRIGATION INVESTIGATIONS—RESULTS OF IRRIGATION IN MISSOURI.

Showing growth of strawberry plants on the irrigated plat, with formation of new plants.

Voorhees collected data from private parties in regard to the irrigation of various kinds of garden truck. In most cases the results were equal to those obtained in the experiments made under his personal direction, paying the entire cost of installing the pumping plants, with a profit, in a single season.

An analysis of the rainfall records at Philadelphia, covering a period of seventy years, shows that in considerably more than half the years there was a lack of rainfall in some one month of the growing season to seriously affect the yield of small fruits and garden vegetables, which constitute so large a part of the products of the Eastern farms. Taking Philadelphia records as typical of the eastern United States, and the results so far obtained in New Jersey as a basis for deduction, it will be seen that an irrigation plant would be a profitable investment for most of the farmers living where our large cities provide a ready market for small fruits and vegetables.

It is not likely that the water-right problems which are so large a factor in Western development will prove of equal importance in the East, owing to the larger flow of streams and the fact that the areas to be irrigated will always be restricted, but in many localities there are already indications that important legal problems will have to be solved before irrigation can safely assume the importance which its value will naturally give it. The work of this investigation along the legal and social lines can well be extended to this section. The experience of the West will in time come to be of value in solving the water problems of the East.

Among the important work which needs to be done in the East along agricultural and engineering lines is a study of the cost of installing and operating pumping plants for small areas. Something has already been done along this line and arrangements are being made to continue this more effectively in the future.

RICE IRRIGATION.

During the past season the problems of rice irrigation have received much attention from this Office. The investigations inaugurated have been principally along agricultural and engineering lines. In the Carolinas it has included a study of the methods of storing water to provide a supplemental water supply; the methods of diverting and distributing it over the fields and the problems connected with the regulation of tidal rivers so as to determine what may be done, either by the Government or by the concerted action of private individuals; and the construction and maintenance of levees for the protection of fields against floods or injury from breaks above or below.

Rice growing in the Carolinas and Georgia is not as important an industry as it was fifty years ago. In part, this decline is due to the

cost of labor. The rice fields are located along the low alluvial bottom lands where the greater part of work must be done by hand. This leaves only a small margin of profit at present prices, and the danger of this being occasionally lost through breaks in levees or river floods has tended to retard a revival of what was once an important and valuable industry.

There seem to be two or three questions which this investigation can properly deal with. One is to what extent State or Government aid is required to assist in the regulation of streams, and to study the topography and watersheds of streams to ascertain what measures may be taken to furnish a supplemental water supply through storage.

The growing of rice on the uplands in Louisiana and Texas presents an entirely different condition of affairs. Here the industry has been from the first unusually successful, and it has increased until it has assumed a national importance, promising to make the United States an exporter instead of an importer of this staple product.

Aside from the agricultural questions peculiar to rice farming, the irrigation of these uplands presents new problems in canal construction and the lifting of water. In the arid region streams as a rule have a heavy fall, and it is therefore easy to get water onto the lands to be irrigated by gravity. In the rice districts the water supply is below the lands to be served, in streams which have hardly enough fall to produce a perceptible current, and the water must therefore be raised by pumps. Even with this expense, rice growing has proven remarkably profitable. The rice lands, which were formerly worth from $1 to $3 per acre, and used only for grazing, now sell for from $30 to $50 per acre, and yield an annual return equal to the value of the land. About 250,000 acres of these lands have already been devoted to rice culture, and much more is capable of the same use.

Along a few of the streams used more land has already been devoted to rice than the streams can properly water, and the question of protecting the early users against the demands of those coming later is pressing for settlement. Louisiana has no laws or customs affording this protection. The publications of this Office place at the command of the canal owners and lawmakers of that State the results of the experience of other States and countries, and will afford them the means of enacting a just and intelligent law governing water rights whenever such action becomes necessary.

A report will soon be published showing the methods used in irrigating rice and discussing the problems which have arisen in the rice districts. This investigation should be continued by the experts employed by this Office, whose familiarity with conditions elsewhere makes them especially fitted for the solution of the problems arising in this new field.

IRRIGATION IN THE INSULAR POSSESSIONS OF THE UNITED STATES.

HAWAIIAN ISLANDS.

During the past summer officials of the Hawaiian Islands requested this Office to make such investigation of the irrigation problems of these islands as would furnish the facts needed in framing an effective code of irrigation laws. The need of such legislation is becoming urgent. Large investments in irrigation works to supply water for the growing of cane have made the subject of water ownership and control one of the most important internal questions of these islands. Proposals have been made by private parties to purchase from the government all of the water rights attached to public lands. Wise action on such proposals will be promoted by a thorough investigation of agricultural conditions and the prospective needs of irrigators. An agent is now engaged in collecting facts as to the use of water on these islands.

PORTO RICO.

Large areas in Porto Rico to be productive require irrigation. Legislation will therefore be needed for the establishment of water titles and to protect the holders of these titles in times of scarcity. It is now admitted everywhere that if water laws and land laws had been framed and administered together in the settlement of the arid West many of the complications which now exist could have been averted. The opportunity is now open for inaugurating a comprehensive code of laws in Porto Rico which shall control development from the outset, and it is believed that an investigation to determine the facts on which such laws should be based should be inaugurated at once.

THE NEED OF EARLY AND EFFECTIVE REFORM OF IRRIGATION LAWS.

While the area of land in the West susceptible of reclamation is small when compared to the whole extent of the arid region, it is practically unlimited when reference is had to the water supply. Along almost every stream there is an abundance of irrigable land and a shortage of water. This brings attention to the importance of measurements and experiments to determine how much water is necessary to successful agriculture, and to inaugurate such measures in its distribution and use as will secure the utmost economy. The area ultimately to be reclaimed will depend wholly on the water supply, and any excessive or wasteful use on land already under cultivation deprives other land equally good of that which would give it value, prevents

the increase in homes, and robs the State and community of taxable wealth. The laws of most Western States have recognized this and prohibited the wasteful use of water, but without greater knowledge they can establish no standard by which to determine what is a wasteful use.

The fact that the water supply is the source of all agricultural values also emphasizes the need of an efficient system of public control. Some States have realized this need and have provided for it. Colorado has 75 officials appointed by the governor, whose sole duty is to see that the water supply is properly distributed. Wyoming has a like system, with 48 officials engaged in guarding its water supply. Nebraska also has a similar system. Utah and Idaho have also made partial provision for accomplishing this result. In the other States, where protection is afforded for every other kind of property, water is left to be fought over in the field and in the courts, and even when controversies are settled in this way for one year, the next season of drought is almost certain to bring a renewal of the conflict. In the localities where those using water from a stream can settle their rights satisfactorily to all concerned, there is nothing to prevent newcomers from building other canals, establishing new rights, unsettling existing conditions, and in this way prolonging the anxiety, uncertainty, and controversy indefinitely.

There are other reasons for a prompt and comprehensive study of water-right problems. In every arid State and Territory the acreage of land under ditches already built is largely in excess of the land now being cultivated. In Idaho there are about 1,600,000 acres of land under existing ditches, of which only 600,000 are now being irrigated. In Wyoming there are probably 2 acres under ditches for every acre that is cultivated. Along the Arkansas River in Colorado and in western Kansas, the same conditions prevail. The same is true of the ditches in New Mexico. In the Salt River Valley, in Arizona, the canal systems cover an area of 350,000 acres, of which less than 150,000 are being cultivated. In northern California many completed ditches are only partly used and a few not used at all. The rights to water in most of these States are based upon the estimated capacities of the ditches, and when the lands for which these rights have been acquired are actually brought under cultivation the present difficulties experienced in the distribution of the supply will be greatly enhanced. This makes necessary two things; (1) more effective administrative provisions, and (2) a knowledge of the facts which ought to govern these officials in the performance of their duties. In some of these States the lack of cultivation of the lands under ditches is due to an inadequate water supply. The streams on which they depend have an abundance in the early part of the season, but this is followed by a drought in July and August. Here the remedy will be found in

storage. In other cases, development has simply outrun settlement and only time and effective measures for colonization are required. In others, inadequate water laws and uncertainty regarding water titles is the cause of the delay in making use of the facilities already provided. Farmers do not feel warranted in building laterals, planting crops, and making contracts for water when the most probable result of this outlay will be an injunction suit. The story told on pages 171–183, Bulletin 100 of this Office, shows that this danger is not imaginary.

The investigations of this Office have shown that the boundaries of irrigation districts should follow drainage lines, that rights to water should include all the watershed of the stream, and that administrative control should not be restricted as it is now in some States by arbitrary county boundaries. In several States county commissioners are made water commissioners; but as many streams flow through more than one county, in some cases through six or seven counties, there can be no adequate or proper supervision. Colorado, Wyoming, and Nebraska have each been divided under State laws into irrigation districts based on drainage lines rather than on county lines. This makes possible an effective division of water within the boundaries of these States. Something to supplement State supervision, however, will in time be required. There are interstate questions which can not be ignored, although laws to provide for the proper division of water within a State are a more vital and urgent necessity than measures to settle the division of interstate streams. The study of interstate rights should, however, begin at once. It will be most unfortunate for all concerned to delay this study until the gravity of the issues created shall result in hasty or ill-considered legislation. What is needed is a careful and impartial investigation of this question by competent engineering and agricultural experts. The problems to be solved are primarily agricultural and engineering. The first questions to be determined are: Where is water now being used? Where can it be used to the best advantage? What are the character and extent of vested rights? These matters ought to be settled by the dispassionate, unbiased study of experienced men and not left to be fought over in the courts by warring private interests. It is impossible for Congress to legislate regarding water rights within States without revolutionizing existing conditions in some of the States, and without interfering with vested rights. The differences between State laws and in the character of the rights established under those laws make such a result inevitable. But a commission could determine what proportion of a stream should flow down from the State above to the State below, and leave it to the authorities of the State above to determine what measures shall be taken to accomplish this result, and to the authorities of the State below to determine what shall be done with the

water when they receive it. In this way there would be no interference with vested rights or with State codes of laws, while at the same time, there would be a far better prospect of securing a just and effective division of the supply than through interstate litigation such as is now impending.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION.

POPULAR PUBLICATIONS FOR GRATUITOUS DISTRIBUTION.

(Requests for these publications should be sent to the Secretary of Agriculture or to a Senator or Representative in Congress.)

Farmers' Bulletin No. 46.—Irrigation in Humid Climates. By F. H. King, Professor of Agricultural Physics, College of Agriculture, University of Wisconsin, and Physicist of the Wisconsin Agricultural Experiment Station. Pp. 27, figs. 4.

Treats of the advantages of an abundant supply of soil moisture, the rainfall of the growing season in the United States, water as a plant food, the advantages and disadvantages of irrigation in humid climates, extent of irrigation in the humid parts of Europe, the rainfall of Europe and the Eastern United States, the character and antiquity of European irrigation, fertilizing value of irrigation waters, lines along which irrigation should first develop, land best suited to irrigation in humid climates, waters best suited to irrigation, amount of water needed for irrigation, methods of obtaining water for irrigation, the construction of reservoirs, and methods of applying water.

Farmers' Bulletin No. 116.—Irrigation in Fruit Growing. By E. J. Wickson, M. A., Professor of Agricultural Practice, University of California, and Horticulturist of the California Experiment Station. Pp. 48, figs. 8.

A statement of the relations of irrigation to fruit production, and of irrigation methods, as they have been demonstrated by Pacific coast experience.

Farmers' Bulletin No. 138.—Irrigation in Field and Garden. By E. J. Wickson, M. A. Pp. 40, figs. 18.

This bulletin discusses the irrigation of the field and garden from the standpoint of the individual farmer, and contains instructions on the determination of ditch levels, the measurement of small streams, sources of water supply and their use, including the diversion of water from streams, the development of water in dry creek beds, the development of springs, the collection of water from the sides of canyons and ravines, tunneling for water, flowing wells, pumping for irrigation, and the storage of storm water; the distribution of irrigation water, including the location of the farm ditch and the turning of water from ditches; methods of applying water, including flooding, the depressed bed, ditch-bank irrigation, furrow irrigation, raised-bed irrigation, subirrigation, and underflow, and irrigation by sprinkling; the choice of an irrigation method; and the time for the application of water.

Rise and Future of Irrigation in the United States.—By Elwood Mead, Expert in Charge of Irrigation Investigations, Office of Experiment Stations. Pp. iii, 591–612, pls. 5. (Reprint from Yearbook, 1899.)

A popular discussion of this subject under the following heads: Remains of ancient irrigation works; early irrigation in California; beginnings of modern irrigation; cooperative colonies in Colorado and California; corporate canal building and objections to such canals; water-right problems of the arid region; the appearance and resources of the arid region; present and future of irrigation, including growth of irrigation and need of better laws, need of reform in the management of public arid land, influence of the range industries, uncertainty as to State and Federal jurisdiction, complications from lack of uniform water laws, methods and measures needed to develop the arid region, appropriation and distribution of the water supply, public supervision and control of irrigation, and influence of irrigation upon people and country; and the commercial importance of irrigation.

Practical Irrigation.—By C. T. Johnston and J. D. Stannard, Assistants in Irrigation Investigations, Office of Experiment Stations. Pp. 491–512, figs. 8. (Reprint from Yearbook, 1900.)

Gives simple directions for the use of the individual farmer.

TECHNICAL PUBLICATIONS—FOR SALE.

(To secure these publications, address the Superintendent of Documents, Union Building, Washington, D. C., inclosing price given. Remittances must be made by cash or United States postal order. Postage stamps and checks not accepted.)

Bulletin No. 36.—Notes on Irrigation in Connecticut and New Jersey. By C. S. Phelps, B. S., and Edward B. Voorhees, M. A. Pp. 64, figs. 7. Price 5 cents.

This bulletin discusses the need, methods, and history of irrigation in Connecticut, irrigation plants in use in Connecticut, experiments on the effects of irrigation on strawberries, and suggestions regarding irrigation; the need of irrigation in New Jersey, amount of water necessary, storage of water, seepage, cost of irrigation, areas capable of being watered by gravity, irrigation by pumping, irrigation by wells, warping, water meadows, total area irrigable, estimated cost of irrigation and suggestions for small plants, use of irrigation in New Jersey, possibility of pumping large quantities of water from wells for irrigating purposes, and irrigation experiments in New Jersey.

Bulletin No. 58.—Water Rights on the Missouri River and its Tributaries. By Elwood Mead, State Engineer of Wyoming. With papers on the Water Laws of Colorado, by John E. Field, State Engineer; and of Nebraska, by J. M. Wilson, State Engineer. Pp. 80, maps 3, figs. 4. Price 10 cents.

A discussion of the irrigation laws which control the diversion and use of water from the Missouri River and its tributaries. The region covered in this discussion includes Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Wyoming, and the Northwest Territories of Canada.

Bulletin No. 60.—Abstract of Laws for Acquiring Titles to Water from the Missouri River and its Tributaries, with the Legal Forms in Use. Compiled by Elwood Mead, State Engineer of Wyoming. Pp. 77. Price 10 cents.

Includes abstracts of laws and legal forms in use in Colorado, Kansas, Montana, Nebraska, South Dakota, Wyoming, and the Northwest Territories of Canada.

Bulletin No. 70.—Water-Right Problems of Bear River. By Clarence T. Johnston and Joseph A. Breckons. Pp. 40, pls. 9. Price 15 cents.

Presents some of the water-right complications of interstate streams as illustrated on Bear River. The bulletin discusses the water supply of the river and its diversion and the controversies which have arisen regarding water rights and the need of uniform laws.

Bulletin No. 73.—Irrigation in the Rocky Mountain States. By J. C. Ulrich. Pp. 64, pls. 10. Price 10 cents.

Explains the agricultural conditions prevailing and the methods of acquiring and using water for irrigation practiced in that portion of the arid region covered more particularly by the States of Colorado, Wyoming, Utah, Idaho, and Montana, in which the conditions and methods are somewhat similar.

Bulletin No. 81.—The Use of Water in Irrigation in Wyoming and its Relation to the Ownership and Distribution of the Natural Supply. By B. C. Buffum, M. S., Professor of Agriculture and Horticulture, University of Wyoming, and Vice-Director of Wyoming Agricultural Experiment Station. Pp. 56, pls. 8. Price 10 cents.

This bulletin reports experiments on the duty of water for different crops in Wyoming, and discusses the application and measurement of water conditions affecting the duty and continuous flow as a basis of appropriation.

Bulletin No. 86.—The Use of Water in Irrigation. Report of Investigations made in 1899, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, Assistant. Including Reports by Special Agents and Observers W. M. Reed, W. H. Code, W. Irving, O. V. P. Stout, Thomas Berry, S. Fortier, R. C. Gemmell, G. L. Swendsen, and D. W. Ross. Pp. 253, pls. 50, figs. 18. Price 30 cents.

This bulletin explains the methods in use in the arid States in the distribution and use of water in irrigation. It gives a large number of measurements made to determine the duty of water and the losses by seepage and evaporation from canals, and discusses the methods by which the water supply may be more effectively and economically utilized in the production of crops.

Bulletin No. 87.—Irrigation in New Jersey. By Edward B. Voorhees, M. A., Director New Jersey Agricultural Experiment Stations and Professor of Agriculture, Rutgers College. Pp. 40, figs. 5. Price 5 cents.

Results of experiments conducted for the purpose of determining whether irrigation during short periods of drought in regions where the rainfall is usually sufficient

for the maximum growth of crops will sufficiently increase the yield to pay for the works necessary to obtain the supply of water.

Bulletin No. 90.—Irrigation in Hawaii. By Walter Maxwell, Ph. D., Director and Chief Chemist, Hawaiian Experiment Station. Pp. 48, pls. 6, figs. 3. Price 10 cents.

Discusses the climatic, soil, and other conditions as affecting irrigation in Hawaii, and gives the results of irrigation experiments, especially with sugar cane, carried on by the author for a number of years.

Bulletin No. 92.—The Reservoir System of the Cache la Poudre Valley. By E. S. Nettleton. Pp. 48, pls. 14. Price 15 cents.

A description of the reservoir system of the Cache la Poudre Valley, showing the benefits to be derived from the construction of reservoirs for the storage of water for irrigation.

Bulletin No. 96.—Irrigation Laws of the Northwest Territories of Canada and Wyoming, with Discussions by J. S. Dennis, Deputy Commissioner of Public Works, Canada, and Fred Bond, State Engineer of Wyoming, and J. M. Wilson, Agent and Expert, Irrigation Investigations, Office of Experiment Stations. Pp. 90, frontispiece, pls. 5. Price 10 cents.

Texts of the irrigation laws of the Northwest Territories of Canada and Wyoming, with the regulations, forms, and methods of procedure adopted in the administration of these laws, and a discussion of the principles underlying the laws and the methods followed in their enforcement.

Bulletin No. 100.—Report of Irrigation Investigations in California under the direction of Elwood Mead, assisted by William E. Smythe, Marsden Manson, J. M. Wilson, Charles D. Marx, Frank Soulé, C. E. Grunsky, Edward M. Boggs, and James D. Schuyler. Pp. 411, pls. 29, figs. 16. Price cloth $1.25, paper 90 cents.

This report deals with investigations carried on during the summer of 1900 in cooperation with the California Water and Forest Association. In addition to a review of the agricultural situation in the State, it presents a compehensive discussion of the water laws and customs under which irrigation is practiced in California as typified by the conditions in Honey Lake Basin, and on Yuba River, Cache Creek, Salinas River, San Joaquin River, Kings River, Los Angeles River, Sweetwater River, and San Jacinto River. It describes the methods and means by which water is diverted from these streams and used in irrigation, and the indefinite and excessive appropriations of water and the resulting litigation, and discusses the evils resulting from absence of State control of streams.

Bulletin No. 104. Report of Irrigation Investigations for 1900 under the supervision of Elwood Mead, Expert in Charge of Irrigation Investigations, including reports by special agents and observers W. M. Reed, W. H. Code, A. J. McClatchie, W. Irving, J. M. Wilson, R. C. Gemmell, G. L. Swendsen, O. V. P. Stout, W. H. Fairfield, D. W. Ross, O. L. Waller, S. Fortier, and J. C. Nagle. Pp. 334, pls. 25, figs. 29. Price 50 cents.

This report describes the study of the agricultural and engineering problems of irrigation made in the arid States and Territories during 1900. Among the subjects

dealt with are the amount of water used in irrigation, the losses from canals by seepage and evaporation, and the causes and effects of these losses. Data are presented showing the cost and value of pumping for irrigation, and the value of water per acre-foot as measured in the crops grown. Efforts to improve the methods of measuring and recording the volume of water used are described, and some of the instruments designed for this purpose are illustrated. Studies to determine the amount and effect of silt on the operation of canals and the permanence of reservoirs are described, and the relation of all facts gathered to the problems of future development pointed out.

Bulletin No. 105. Irrigation in the United States. Testimony of Elwood Mead, Irrigation Expert in Charge, before the United States Industrial Commission, June 11 and 12, 1901. Pp. 47, pls. 12, fig. 1. Price 15 cents.

The testimony contained in this bulletin presents a review of the irrigation situation in the United States, including not only the arid region of the West, but also the humid sections of the South and East, and also deals briefly with the practical aspects of extending public aid to irrigation either through the State or National Governments. The heads under which the review is given are as follows: Beginnings of irrigation in the United States; Importance of irrigation in the United States; Irrigation in the United States the result of private enterprise; Evolution of water laws in the arid region; Establishment of titles to water; Meaning of term "water right," and water-right contracts; Building of canals and distribution of water; Losses of water by seepage; Filling of canals by silt; Controversies over titles to water; Principles governing water rights in Canada and Wyoming; Storage of water for irrigation; Irrigation a State question; Leasing of the public grazing lands; National aid extended by land grants; Cost and value of irrigation; Products of the arid region; National aid for irrigation; Interstate water-right complications; Irrigation in the humid sections, and Filling of reservoirs by silt.

SCOPE AND RESULTS OF THE NUTRITION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

HISTORICAL INTRODUCTION.

Not the least potent of the factors that influence the welfare of a country is the rational and satisfactory nutrition of its people. Consonant with the increasing growth and prosperity of the United States and the development of education and of scientific research within its territory is the fact that our Government is now promoting a systematic and comprehensive inquiry into the nutrition of man, and especially the food and nutrition of its own people. This inquiry is authorized by Congress, aided by appropriations from the Federal Treasury placed in charge of the Secretary of Agriculture, and carried out in different parts of the United States. One most important feature is the cooperation with universities, colleges, experiment stations, and philanthropic organizations, literally from Maine to California and from Minnesota to Alabama. Another advantage is found in the fact that while the institutions and investigators have that liberty of initiative and action which is so essential for scientific research, the several inquiries are so coordinated and the investigators are so aided by counsel and by the collating of the results of inquiry elsewhere as to make both the individual investigators and the product as a whole far more useful than would otherwise be possible. Part of the fund provided by Congress is expended under the sole and immediate care of the Department; part is distributed in various places and used, not as compensation for services so much as an encouragement to research. The cooperating investigators and institutions are contributors to the enterprise, and the spirit of cooperation thus becomes in itself an important agency for elevating the quality and increasing the quantity of the work, diffusing the results, and insuring their most useful application. It thus comes about that an appropriation of public money, comparatively insignificant in amount, has assumed a noteworthy significance in its scientific, educational, sociological, and economic results.

The sums voted by Congress for this especial item of nutrition

investigations in the general appropriations for the Department of Agriculture have been:

For the fiscal year 1894–95	$10,000
For the fiscal year 1895–96	15,000
For the fiscal year 1896–97	15,000
For the fiscal year 1897–98	15,000
For the fiscal year 1898–99	15,000
For the fiscal year 1899–1900	15,000
For the fiscal year 1900–1901	17,500
For the fiscal year 1901–2	20,000

The contributions from other sources are not easily estimated in terms of money, since they consist in large part of use of laboratories, apparatus, and other facilities for research, and the counsel and help of experts and other gratuitous service. The State of Connecticut makes a small annual appropriation for nutrition investigations to the Storrs Experiment Station, which cooperates with the Department. A considerable number of experiment stations, educational institutions, philanthropic organizations, and private individuals have given sums of money to promote the cooperative inquiry.

It would be entirely wrong to attribute the whole of the results described beyond to this especial inquiry. Indeed, it represents simply a special movement begun after others had been long in operation, and is now running parallel with them.

NUTRITION INVESTIGATIONS IN THE UNITED STATES.

Until within a very few years, the most definite knowledge regarding the nutritive values of food and the laws of nutrition has come from Europe, but lately such information has been accumulating quite rapidly in the United States. A complete historical review of investigations upon food and nutrition in this country would include numerous instances in which studies of food were incidental to other inquiries. A considerable amount of valuable information has been obtained by physicians, by State boards of health, and by specialists in physiology, hygiene, and dietetics. Some of the latter inquiries are of especial value, as, for instance, those of Professor Chittenden, of Yale University. Of noteworthy importance are the studies of the chemical composition and adulteration of food materials made in the Division of Chemistry of the Department of Agriculture by Prof. H. W. Wiley and others.

The purpose of the present article is to refer to the special work which has developed into the cooperative inquiry now being carried on under the auspices of the Department of Agriculture, through the Office of Experiment Stations, and to describe some of the methods, progress, and results of that enterprise. This inquiry had its inception in a study of the chemical composition of food-fishes and inver-

tebrates undertaken by Prof. W. O. Atwater in 1877, and continued until 1882, in the laboratory of Wesleyan University, at the instance of Prof. S. F. Baird, secretary of the Smithsonian Institution and United States Commissioner of Fish and Fisheries. In connection with this work, similar investigations of other animal and some vegetable products were undertaken a little later (1884) on behalf of the United States National Museum. About the same time (1886) the first extended inquiry regarding the statistics of food consumption in the United States was undertaken by Hon. Carroll D. Wright, as chief of the Massachusetts Bureau of Statistics of Labor, and the chemical results were computed and reported by Professor Atwater. In 1890 the Storrs Experiment Station, under the direction of Professor Atwater, in cooperation with Hon. Carroll D. Wright as United States Commissioner of Labor, began a series of dietary studies which continued for several years.

Nearly all the work of these inquiries was done at Wesleyan University, and, with the exception of those under the auspices of the Massachusetts Bureau and United States Department of Labor and the Storrs Experiment Station, the larger share of the expense was borne by private individuals. Associated with Professor Atwater in the inquiries were Messrs. C. D. Woods, now professor in the University of Maine and director of the experiment station of that State; J. H. Long, now professor in the Northwestern University Medical School; E. B. Voorhees, now professor in Rutgers College and director of the New Jersey experiment stations; J. M. Bartlett, now chemist of the Maine Experiment Station; G. P. Merrill, now curator of the United States National Museum and professor in Columbian University; W. H. Jordan, late of the Maine State University and Experiment Station and now director of the New York State Experiment Station; E. B. Rockwood, now professor and dean of the medical school of the University of Iowa; G. Gehring, since deceased, and the late Prof. H. B. Gibson, of the University of Missouri, besides others who also rendered most valuable service. Among those who supported the earlier inquiries by private gifts were Messrs. F. B. Thurber, E. G. Blackford, and Mark Hoyt, of New York City; G. E. Roberts, of Boston, and J. W. Alsop, H. G. Hubbard, A. R. Crittenden, E. K. Hubbard, and I. E. Palmer, of Middletown, Conn. It is interesting to note, in these earlier studies, the same principle of the encouragement of research by public funds and official recognition, when it was aided by private support, as is now being followed in the nutrition investigations under the auspices of the Department of Agriculture.

The results of these inquiries gradually came into notice. The bearing of such research upon household, agricultural, and national economics became evident, and as early as 1890 steps were taken to secure an appropriation from Congress in order to enlarge their scope and useful-

ness, but nothing definite was accomplished until 1894. In that year the experiment stations were authorized by Congress to cooperate with the Secretary of Agriculture in the study of the food and nutrition of man, and were called upon to report to him the results of such investigations as they might carry out. At the same time Congress provided a special appropriation to enable the Secretary of Agriculture to prosecute inquiries in this direction.

GENERAL LINES OF WORK.

The general lines along which the investigations have been conducted may be briefly stated as follows:

Observations have been made on the nutritive value and cost of different food materials in various localities in the United States.

Studies have been made of actual dietaries in order to learn the kinds and amounts of food materials consumed by persons in different localities, of different occupations, ages, and sex, and under varying conditions.

The digestibility of certain articles of food, especially cereal products and meats, has been studied, and comparisons have been made between the cheaper and more expensive foods to determine the relative effect of their use on health and comfort.

Studies have been conducted to determine the losses in nutritive value from various modes of cooking and to find out the most economical methods for utilizing different food materials.

Metabolism experiments have been made with the respiration calorimeter. The principal theme has been the transformation of the energy of food materials in the body and the use which the body makes of the energy so transformed. One important topic has been the relation of muscular work to digestibility and metabolism. The amounts of food consumed and metabolized by men under different conditions of work and rest have been observed. The fuel values of the fats and carbohydrates have been compared.

Determinations of the heats of combustion of food materials have been made with the bomb calorimeter.

Methods of investigation are being studied with reference to their improvement, and constant effort is being made to devise better forms of apparatus. The most important improvements in apparatus thus far made have been the devising and construction of the Atwater-Rosa respiration calorimeter and the improving of the bomb calorimeter by Atwater and associates.

The fact was early recognized that compilations and summaries of the investigations which have been carried on in Europe and this country were necessary. In order to conduct any kind of research most efficiently it is necessary to know what has been accomplished by others in order that the investigator may profit by their results and

that an unnecessary duplication of effort may be avoided. Furthermore, summaries of previous investigations are of great value in suggesting lines of research and in awakening the interest of investigators by showing past achievements.

The current literature of the nutrition of man, which is now quite voluminous, is being regularly followed up, and such abstracts and compilations are being made as will promote the interests of the investigations.

The rapid accumulation of material which must be made ready for publication in both technical and popular form necessitates a large amount of editorial work. The correspondence connected with these investigations has grown to very considerable dimensions.

ORGANIZATION OF THE WORK.

The nutrition investigations of the Department of Agriculture are conducted through the Office of Experiment Stations, the general supervision of these investigations having been assigned by the Secretary of Agriculture to the Director of that Office. The immediate supervision of this enterprise has been intrusted to Prof. W. O. Atwater, as special agent in charge of nutrition investigations. Professor Atwater's headquarters are at Middletown, Conn. The administrative and editorial work connected with these investigations is conducted at Washington and Middletown. The investigations themselves are conducted in different places, the general policy being to make particular institutions centers of investigation in special lines. The cooperating institutions have in most cases contributed material assistance, especially as regards laboratory rooms and appliances and the services of skilled investigators. This method of cooperation has some very decided advantages, particularly in the fact that many different institutions, representing the varied interests of people in widely separate regions, are united in the study of prevalent conditions and in efforts toward improvement. Besides this, the funds provided by the Department are used economically and are supplemented by the resources of the institutions and often by means from other sources. While a large amount of work is being done, the interest is widely extended and the results are given a greater practical usefulness.

WORK OF THE WASHINGTON OFFICE.

Besides the general supervision of the plans and expenditures, the work of the Washington Office in relation to the nutrition investigations has included the preparation of popular bulletins; the compilation of technical summaries of investigations; editorial work in perfecting the details of reports of investigations; collection of bibliographical data; the abstracting of the literature of nutrition, partly for publication in the Experiment Station Record; the conducting of

a large correspondence growing out of nutrition investigations, and the distribution of publications on this subject. This work is in charge of Dr. C. F. Langworthy. The following publications have been prepared in this Office by Dr. Langworthy: Farmers' Bulletin No. 74, Milk as Food; No. 85, Fish as Food; No. 128, Eggs and their uses as Food; and No. 58, Appendix, Soy Beans as Food for Man; Circular No. 43, Food Nutrients—Food Economy; Circular No. 46, The Function and uses of Food; and Yearbook articles entitled Food for Man and The Value of Potatoes as Food. The series of farmers' bulletins entitled Experiment Station Work have contained many articles on food and nutrition which has summarized the investigations on this subject conducted by different experiment stations. In the Experiment Station Record the results of current investigations on food and nutrition conducted in this and other countries are summarized. The following publications, prepared by different authors, have been issued by this Office, which have been for the most part based on nutrition investigations in this country and abroad: Farmers' Bulletin No. 93, Sugar as Food, by Mary Hinman Abel; Farmers' Bulletin No. 112, Bread and the Principles of Bread Making, by Helen W. Atwater; Farmers' Bulletin No. 121, Beans, Peas, and Other Legumes as Foods, by Mary Hinman Abel; and Office of Experiment Stations Bulletin No. 56, History and Present Status of Instruction in Cooking in the Public Schools of New York City, by Mrs. Louise E. Hogan, with an introduction by A. C. True; Yearbook, 1899, Development of Nutrition Investigations of the Department of Agriculture, by A. C. True and R. D. Milner.

WORK OF THE MIDDLETOWN OFFICE.

The work of the office of the special agent in charge of the nutrition investigations at Middletown, Conn., has included the planning and direct supervision of these investigations in different parts of the country, the conducting of special investigations with the respiration calorimeter and bomb calorimeter, the compilation of the results of nutrition investigations in this country and abroad, and a large correspondence relating to these investigations. The special investigations carried on here in cooperation with Wesleyan University and the Storrs Experiment Station are briefly described on page 445.

INVESTIGATIONS IN DIFFERENT STATES.

The nutrition investigations conducted in cooperation with colleges, experiment stations, and other agencies in the different States are briefly described in the following pages:

ALABAMA.

Investigations in this State were carried on during the spring of 1895 and the winter of 1895–96 at the Normal and Agricultural Insti-

tute of Tuskegee, in cooperation with Prof. Booker T. Washington, and at the Alabama Polytechnic Institute and the Alabama Experiment Station, Auburn, in cooperation with Prof. B. B. Ross. The work covered a study of the food consumption of the negroes in the neighborhood of the "black belt" of Alabama, and of the chemical composition of the food materials used by negroes. The work was carried on under the immediate supervision of Prof. W. O. Atwater and Mr. Charles D. Woods, of Middletown, Conn., and was aided in many ways by Pres. W. L. Broun, of the Polytechnic Institute, at Auburn. The details of much of the work were in charge of Mr. H. M. Smith, of Middletown, Conn., and Mr. J. W. Hoffman, of the Tuskegee Institute.

The immediate purpose in conducting an inquiry into the food of the colored population of Alabama was to obtain information as to the kind, amounts, and composition of the food materials used. The ulterior purpose was to get light upon the hygienic and pecuniary economy of their diet, its deficiencies, and the ways in which it might be improved and the steps which should be taken to bring about an improvement.

Twenty dietary studies were made with different classes of negro families, from those who had felt the elevating influence of the Tuskegee Institute to families of plantation laborers in the poorest of circumstances. As a result of the studies it was found that the characteristic "hog and hominy" diet in common use was markedly deficient in protein, while furnishing, in many instances, a large amount of energy.

The investigations were not continued after the close of the fiscal year ended June 30, 1896. The results of the investigations are reported in Bulletin No. 38 of this Office on Dietary Studies with Reference to the Food of the Negro in Alabama in 1895 and 1896, by W. O. Atwater and C. D. Woods.

CALIFORNIA.

A series of investigations was begun in cooperation with the University of California in 1896, and is being carried on at the present time. The work in charge of Prof. M. E. Jaffa has included dietary studies of infants, athletes, professional men, fruitarians, and Chinese; digestion experiments with an infant and a fruitarian, and analyses of California food materials. Professor Jaffa has been aided by Messrs. G. E. Colby, F. J. Snow, R. R. Bishop, and C. L. Biedenbach. Valuable aid in the work with the Chinese was also received from Mr. W. N. Fong, instructor in Oriental languages at the University of California.

Besides the lines of inquiry just mentioned, Mr. W. C. Blasdale, instructor in chemistry at the university, made a study of the composition of Chinese vegetable food materials. The work is being continued by Professor Jaffa at the present time.

DIETARY STUDIES.

The results of fifteen studies have already been published in bulletins of the Office of Experiment Stations. A study made with a football team in active training is of interest. It was undertaken especially to secure information regarding the food consumption of men performing severe work under known conditions.

Such data are of value in determining dietary standards, especially the relative amounts of nutrients required by persons performing different amounts of muscular work. A study of the food consumption of the family of a professional man adds further data to those already accumulated in this line. The dietary studies with infants have been by far the most detailed of any which have been carried on in this country, covering in one case the total food consumed by a child from the second to the thirteenth month of its age. Four studies have been reported. The results are of value in throwing light upon the question of the relative food consumption of children of different ages, and affording material for computing dietary standards for infants.

Rice is popularly supposed to constitute the chief food of Chinese, not only at home but in this country. In order to obtain information regarding the peculiarities of the diet of the Chinese in this country three studies were made of Chinese living in or near San Francisco. The results indicate that the diet is not as unusual as is ordinarily supposed, and that while rice forms a considerable portion of the rations their diet can by no means be considered as even approaching a vegetarian diet. The rice constituted between one-third and one-half of the total food consumed, and held much the same relation to the total food of the Chinese as do bread and other cereals, starches, etc., to the total food of the ordinary American family.

While fruit and nuts are ordinarily considered in the light of accessory or supplementary foods, there are those who live entirely upon these articles of diet. In order to find the actual consumption of nutrients and energy by such persons studies were made of the food consumption of a family living almost entirely upon fruits and nuts. The investigation is still being pursued and the results thus far obtained are not sufficient to warrant any definite conclusions. It is very noticeable, however, that the actual amounts of nutrients and energy in the diets of the persons studied were much smaller than is ordinarily found in diets of average persons under like conditions of age, sex, and muscular activity. In all seven dietary studies have been made with fruitarians.

DIGESTION EXPERIMENTS.

Two digestion experiments have been made; one with an infant and one with a child living upon a diet made up entirely of fruits and

nuts. The results of the experiment with the infant substantiate those of similar experiments elsewhere. The digestion experiment with a fruit and nut diet seems to indicate that the nutrients and energy in such a diet may not be much below that of the nutrients and energy in the average mixed diet. In some of the work the metabolism of nitrogen was also studied.

COMPOSITION OF CALIFORNIA FOOD MATERIALS.

In connection with the investigations analyses of a considerable number of California food materials, more especially fruits and Chinese food materials, have been made. Reference has already been made to the quite detailed study of the composition and economic value of the Chinese vegetable food materials found in the Chinese markets of San Francisco.

PUBLICATIONS.

The results thus far published are given in the following bulletins of the Office of Experiment Stations: Bul. No. 68, A Description of Some Chinese Vegetable Food Materials and their Economic and Nutritive Value, by W. C. Blasdale; Bul. No. 84, Nutrition Investigations at the California Agricultural Experiment Station, 1896–1898, by M. E. Jaffa; and Bul. No. 107, Nutrition Investigations Among Fruitarians and Chinese at the California Agricultural Experiment Station, 1898–1901, by M. E. Jaffa.

CONNECTICUT.

The investigations in this State have been carried on in connection with the Storrs Experiment Station and Wesleyan University, and under the direction of Prof. W. O. Atwater, who, as special agent in charge of the nutrition investigations, also has the general oversight of the work in other parts of the country. Prof. C. D. Woods, now of the Maine State University and Experiment Station; Prof. E. B. Rosa, of Wesleyan University; Dr. F. G. Benedict, and Mr. A. P. Bryant have shared in the direction of the work. The details of the inquiry have been carried out with the assistance of a considerable number of persons, several of whom have been associated with the Storrs Experiment Station and Wesleyan University.

The chief line of inquiry has been the study of the metabolism of matter and energy in the human body by means of the respiration calorimeter, briefly described on page 446. In addition there has been a considerable amount of work along other lines, including the compilation of results of earlier investigations and other literary work, digestion experiments, analyses of food materials and excretory products, studies of dietaries, and the developing of apparatus and methods.

The Storrs Experiment Station had already done considerable work along similar lines before the institution of the national inquiry into the food and nutrition of man, and has continued such work from the beginning of this inquiry to the present time. Since 1895 the State has annually appropriated $1,800 to the station, the major portion of which has been available for the nutrition investigations.

IMPROVEMENT OF APPARATUS—BOMB AND RESPIRATION CALORIMETERS.

One important function of food is to furnish energy to the body. For a thorough study of the laws of nutrition, therefore, and of the uses and nutritive values of food, there must be a means of determining the amounts of potential energy in the food consumed and in the products formed from the food by the body. Since different forms of energy may be transformed into heat, the energy of a substance may be expressed in terms of heat, and therefore the potential energy of a substance may be measured by the heat developed when the substance is burned in oxygen. In the investigations conducted under the auspices of the United States Department of Agriculture a very satisfactory method is employed whereby the amount of heat thus developed by food materials is determined. The result obtained in this way is called the "heat of combustion" of the material burned. The apparatus used for this purpose is called a calorimeter. Various forms of calorimeter have been devised. That form now in use in connection with the nutrition investigations of this Office is called a bomb calorimeter. The early work done by the Connecticut Storrs Station along this line was with a Stohmann calorimeter, a modification of an earlier form devised by Thompson. This apparatus proved unsatisfactory, and the attempt was made to secure a better one. The bomb calorimeter devised by Berthelot was superior, but was very costly because of the large amount of platinum used in its construction. With the aid of Professor Hempel, of Dresden, Professor Atwater and his associates succeeded in modifying the Berthelot apparatus, especially with regard to the amount of platinum used, so that a very accurate and satisfactory calorimeter has been obtained at a much lower cost. By the use of this apparatus the heats of combustion of a large number of different food materials have been determined.

Studies of some of the more fundamental laws of animal nutrition have been carried on for the purpose of determining what uses the body makes of its food under different conditions. Special inquiries of this nature were begun by Professor Atwater in 1892, by means of an apparatus known as a respiration calorimeter, so arranged that a man may spend a number of days in comparative comfort within it, and so manipulated that the metabolism of both matter and energy in his body may be determined. In devising and perfecting the apparatus and in carrying out the investigations with relation to the measure-

ments of heat and mechanical work, Professor Atwater was assisted by Dr. E. B. Rosa, professor of physics in Wesleyan University, and others. Several years were spent in the development of this apparatus and the elaboration of methods of experimenting with it.

The Atwater-Rosa respiration calorimeter is an air-tight copper box inclosed in zinc and wooden cases and of such a size that a man can remain in it in comparative comfort for a number of days. In experiments conducted at Middletown, Conn., a man has remained in the apparatus some two weeks. The copper box or chamber is some 7 feet long, 4 feet wide, and 6 feet high. It is provided with a folding cot, table, and chair. Food and other necessary articles are passed in and out through a tube at one side of the chamber. A window in front admits light, and the man inside of the chamber can communicate with those outside by means of a telephone. The chamber is supplied with fresh air, and the amount and composition of the air which enters and leaves it are determined, the latter containing the products of respiration. The amount and composition of the food and excretory products are also determined. The heat given off by the man's body is measured, as well as the heat value of the food and excreta. A stream of cold water of known temperature and volume circulates through the interior of the chamber in pipes. It absorbs the heat given off by the man's body, and permits of its measurement, at the same time serving to keep the temperature of the interior cool.

At the present time the respiration calorimeter is being much improved, and it is expected that in the near future it may be made into a so-called closed circuit apparatus, in which the air drawn from the respiration chamber is freed from its carbon dioxid, oxygen added, and the air returned to the chamber. When this is accomplished, the apparatus will permit of still more valuable and accurate research.

METABOLISM EXPERIMENTS.

The development of apparatus and methods has been both costly and time-consuming, but the results bid fair to be of no little value in determining the physiological demands of the human body under different conditions, in studying the way different foods are used in the body, and in carrying out various abstract lines of physiological research. In some of the experiments the subject worked very hard driving a stationary bicycle; in others, he worked as little as possible, spending his time in reading or writing. In the work experiments the amount of work performed was measured. Such experiments show the value of different foods for the production of work and serve as a means for judging the power of the human body considered as a machine. The results of nineteen experiments covering sixty-five days have already been published in bulletins of the Office of Experiment

Stations, and the results of fourteen further experiments covering forty-one days await publication.

DIETARY STUDIES.

Although the Storrs Experiment Station has for a considerable number of years studied the food consumption of families, boarding houses, clubs, institutions, and the like, the number of dietary studies which has been made in cooperation with the Department has not been large. In 1897 a study was made of the food consumption of the Yale University boat crew while in training at New Haven, and later immediately before the race with Harvard University on the Thames near New London. The results of these studies will be referred to in connection with those of similar studies made at the same time with the Harvard University boat crews, and referred to in the section "Nutrition investigations in Massachusetts" (p. 453).

An inquiry was also made concerning the food consumption, digestion, and nitrogen metabolism of bicyclists under conditions of unusual and severe mental and muscular strain. The four studies which were carried on were with three different men. The food eaten was carefully weighed, sampled, and analyzed, and samples were taken of the excretory products. The men were engaged in a six-day bicycle race and were at work from twelve to twenty-three hours each day. The results, therefore, are of considerable interest in showing the food demands of persons under such extraordinary conditions. As was to be expected, the quantity of food consumed was large, but not nearly as large as would be necessary in order to cover the demands of the body under the circumstances. Unfortunately, no estimate could be made of the amount of body fat lost. Prof. R. C. Carpenter, of Cornell University, made estimates of the amount of work done by the riders, which showed that their efficiency must have been far greater than that of any heat engine that has yet been devised.

DIGESTION EXPERIMENTS.

In connection with the metabolism experiments with the respiration calorimeter above mentioned, digestion experiments have been carried on for the purpose of studying the digestibility of the food used in the metabolism experiments and throwing light upon the digestibility of different rations under different conditions. The detailed results of much of this work have not yet been published, but the work has served an important purpose as a means of verifying proposed factors for the digestibility of different classes of food materials, and also the factors proposed for heats of combustion and for fuel value.

ANALYSES OF FOOD MATERIALS AND DETERMINATION OF HEATS OF COMBUSTION.

The metabolism experiments, dietary studies, and digestion experiments have involved a considerable amount of analytical work and the heats of combustion of a large number of samples of food have also been determined. These determinations of heats of combustion are made by the bomb calorimeter, and considerable attention has been devoted to the perfection of the apparatus and methods by which it is possible to determine the total or potential energy in a given material with ease and accuracy. A good deal of attention has been paid to the improvement of the bomb calorimeter and accessory apparatus by Mr. O. S. Blakeslee, formerly mechanician at Wesleyan University, to whom much of the credit belongs.

MISCELLANEOUS INQUIRIES.

In addition to the lines of inquiry above stated a short study was made of the composition of raw and cooked potatoes and the losses during cooking. This study was made for the purpose of duplicating some of the results obtained by Professor Snyder at the Minnesota Experiment Station (see p. 455).

Considerable attention has also been given to analytical and experimental methods involved in the various lines of investigation which have been carried on in Connecticut, the detailed enumeration of which is unnecessary.

PUBLICATIONS.

The results of above investigations are published in the following bulletins of the Office of Experiment Stations: Bul. No. 44, Report of Preliminary Investigations on the Metabolism of Nitrogen and Carbon in the Human Organism, by W. O. Atwater, C. D. Woods, and F. G. Benedict; Bul. No. 63, Description of a New Respiration Calorimeter and Experiments on the Conservation of Energy in the Human Body, by W. O. Atwater and E. B. Rosa; Bul. No. 69, Experiments on Metabolism of Matter and Energy in the Human Body, by W. O. Atwater and F. G. Benedict, with the cooperation of A. W. Smith and A. P. Bryant; Bul. No. 109, Further Experiments on the Metabolism of Matter and Energy in the Human Body, by W. O. Atwater and F. G. Benedict, with the cooperation of A. P. Bryant, A. W. Smith, and J. F. Snell; Bul. No. 75, Dietary Studies of University Boat Crews, by W. O. Atwater and A. P. Bryant; Bul. No. 98, The Effect of Severe and Prolonged Muscular Work on Food Consumption, Digestion, and Metabolism, by W. O. Atwater and H. C. Sherman, and Bul. No. 43 (third article), Losses in Boiling Vegetables and the Composi-

tion and Digestibility of Potatoes and Eggs, by H. Snyder, Almah J. Frisby, and A. P. Bryant. In addition to these there is a considerable amount of material which has not yet been published.

The bulletins reporting compilations of the work of earlier investigators include Office of Experiment Stations Bulletin No. 21, The Method and Results of Investigations on the Chemistry and Economy of Food, by W. O. Atwater; Bulletin No. 28, The Chemical Composition of American Food Materials, by W. O. Atwater and Chas. D. Woods; a revision of this bulletin by W. O. Atwater and A. P. Bryant; Bulletin No. 45, A Digest of Metabolism Experiments, in which the Balance of Income and Outgo was Determined, by W. O. Atwater and C. F. Langworthy. Popular summaries, published as Farmers' Bulletins by the Department of Agriculture, have been prepared as follows: Farmers' Bulletin No. 23, Foods: Nutritive Value and Cost, by W. O. Atwater; Farmers' Bulletin No. 34, Meats: Composition and Cooking, by Chas. D. Woods; Farmers' Bulletin No. 142, The Nutritive and Economic Value of Food, by W. O. Atwater; Food and Diet, Yearbook, 1894; and Some Results of Dietary Studies, A. P. Bryant, Yearbook, 1898.

ILLINOIS.

Nutrition investigations have been carried on in cooperation with the Hull House and the Lewis Institute of Chicago and the University of Illinois. The lines of work undertaken have been dietary studies, investigations of food and milk supply of Chicago, losses in cooking meat, digestion experiments in which meat formed a considerable part of the diet, and analyses of food materials.

The work in Chicago was under the immediate direction of Miss Jane Addams, of Hull House, and Prof. G. N. Carman, director of Lewis Institute. The work at the University of Illinois was carried on by Prof. H. S. Grindley.

DIETARY STUDIES.

The dietary studies were carried on mainly for the purpose of studying the food consumption of persons of foreign birth or parentage residing in congested districts of Chicago. Fifty such studies were made among families of Italians, French Canadians, Russian Jews, and Bohemians. The details of these studies were carried on by Miss Caroline Hunt, although valuable aid was received at the outset from Mr. H. M. Smith, of Middletown, Conn. The results seem to indicate that the diet of foreigners in this country approaches more and more nearly that of the average American diet the longer they have resided in this country. In addition to these three dietary studies were made of well-to-do professional men residing in Chicago and two were carried on by Professor Grindley, in connection with his work at the University of Illinois. In these he was assisted by Mr. J. L. Sammis and Mr. E. A. Paul.

LOSSES IN COOKING MEAT.

In order to study the losses which may occur during the frying, roasting, and boiling of meat, Professor Grindley began in 1898 a series of experiments which he has continued to the present time. The results of 25 experiments, 23 of which were in duplicate, have already been published; the results of 24 more, all in duplicate, await publication. These experiments have been made with frying and boiling; with lean and fat meat; and with beef, veal, and mutton. The results indicate that there was no great loss during the process of frying and roasting meat, and that in boiling meat there was no loss provided the liquor in which the meat is cooked is utilized for gravy or in other ways. If the liquor is not used the loss may amount to considerable. These cooking experiments have involved a very large number of analyses, not only of raw and cooked meat, but of meat broths. The method of experimenting had also to be elaborated. In the prosecution of this work Professor Grindley received the valuable cooperation of Mr. H. McCormack and Mr. H. C. Porter, not only in the experiments just described, but in the digestion experiments.

DIGESTION EXPERIMENTS.

Besides the cooking experiments, Professor Grindley has made up to the present time 37 digestion experiments in which meat forms an important part of the diet. In some of these experiments, indeed, only sufficient other food materials were used to make the diet palatable. The meat used has been cooked in different ways, and has been of different degrees of fatness. The results have not yet been published. All of these 37 experiments are also nitrogen metabolism experiments, since the nitrogen of income and outgo was determined.

These experiments were carried on with men, and may be called natural-digestion experiments. In addition to these natural-digestion experiments a large number of artificial experiments have been made, in which the digestibility of different kinds of meat, different degrees of fatness, and cooked in different ways has been studied by means of digestion in pepsin solution, and the time required for complete digestion noted. The results of these experiments, like those of the natural-digestion experiments, still await publication.

The number of analyses of food materials, excretory products, and residues from artificial-digestion experiments has been very large. The results of the investigations can hardly fail to be of far-reaching value.

PUBLICATIONS.

The results of so much of these investigations as has been published are reported in the following bulletins of the Office of Experiment

Stations: Bul. No. 55, Dietary Studies in Chicago in 1895 and 1896, conducted with the cooperation of Jane Addams and Caroline L. Hunt, of Hull House, reported by W. O. Atwater and A. P. Bryant; Bul. No. 91, Nutrition Investigations at the University of Illinois, North Dakota Agricultural College, and Lake Erie College, Ohio, 1896–1900, by H. S. Grindley and J. L. Sammis, E. F. Ladd, Isabel Bevier, and Elizabeth C. Sprague. (The first part only of this bulletin is descriptive of work in Illinois.) Bul. No. 102, Experiments on the Losses in Cooking Meat, 1898–1900, by H. S. Grindley, with the cooperation of H. McCormack, and H. C. Porter.

INDIANA.

The investigations in Indiana were made at Purdue University in 1895 and 1896 by Prof. W. E. Stone. They comprised two studies of dietaries. The investigation has not been continued since 1896. In carrying on these dietary studies, Professor Stone received the efficient aid of Mr. H. M. Smith, of Middletown, Conn. The results of the investigation are published in the following bulletin of the Office of Experiment Stations: Bul. No. 32, Dietary Studies at Purdue University, Lafayette, Ind., in 1895, by W. E. Stone.

MAINE.

The investigations in this State have been carried on at the University of Maine and the Maine Experiment Station by Prof. W. H. Jordan and Prof. C. D. Woods. The lines followed have been the study of dietaries and study of the digestibility and nutritive value of bread. A considerable amount of time has also been devoted to the study of experimental methods. In the prosecution of the work Professor Jordan and Professor Woods had the cooperation of Mr. F. C. Moulton and Mr. L. H. Merrill.

DIETARY STUDIES.

In 1895 a series of dietary studies was made of the students at the University of Maine. The attempt was made to control the sources of protein, furnishing it in both cheap and expensive forms. The influence of an abundance of milk in the dietary was also studied. The results obtained were compared with those of a dietary study made under normal conditions. The studies were made at different times of year and observations were made of the effect of temperature upon food consumption. It was found that there was much less food consumed in warm weather than in cold. The free use of milk did not seem to increase the total amount of nutrients eaten; the extra amount of milk consumed apparently replaced other food materials. The dietaries in which the milk was more abundant were less costly

than those in which but little milk was used. The cost of the ration varied in the different studies from 25 cents to 34 cents per man per day. During the progress of the studies a large number of food materials and excretory products were sampled and analyzed.

STUDIES OF DIGESTIBILITY AND NUTRITIVE VALUE OF BREAD.

These studies are carried on by Professor Woods. They were begun in 1895 and are being continued at the present time. The plan of the investigation involved a study of the digestibility of bread made from different kinds of flour. Twenty-four digestion experiments with healthy men were carried on, 13 with bread made from fine wheat flour, 5 with bread made from whole-wheat flour, and 6 with bread made from graham flour. Similar experiments are being continued at the present time, but the results thus far obtained are not sufficient for drawing definite conclusions regarding the relative digestibility of bread made from different kinds of wheat flour.

In order to study the true digestibility of bread, it became necessary to determine as accurately as possible the quantity of metabolic products in the feces; a considerable amount of experimental study was given this question.

The digestibility of the protein of the bread was also determined in a number of cases by artificial digestion in pepsin solution.

Another line of inquiry relating to the nutritive value of bread was the difference in the composition of the bread made with skim milk instead of water. A still further inquiry was that regarding the losses in bread making. The results of 6 experiments in which the loss of nutritive material during baking was studied indicate a loss of not far from 2 per cent of the dry material. This loss falls chiefly upon the fats and carbohydrates; the results agree quite closely with those obtained in experiments in New Jersey. These investigations involved a large number of chemical analyses.

PUBLICATIONS.

The results of the investigations in Maine are published in the following bulletins of the Office of Experiment Stations: No. 37, Dietary Studies at the Maine State College in 1895, by Whitman H. Jordan, Director of Maine Agricultural Experiment Station; and No. 85, A Report of Investigations on the Digestibility and Nutritive Value of Bread, by Charles D. Woods, director, and L. H. Merrill, chemist, Maine Agricultural Experiment Station. Other results await publication.

MASSACHUSETTS.

In the spring of 1898 Prof. W. O. Atwater and Mr. A. P. Bryant, assisted by some other members of the force of the Office of Experiment Stations, made a study of the food consumption of the "varsity"

and freshman crews of Harvard University and that of an individual member of one of the crews. In the prosecution of these studies of the Harvard crews the cooperation of Dr. G. W. Fitz, of the Lawrence Scientific School, was obtained. These studies and those of the Yale crews previously mentioned (p. 448) were carried on at the same time during the latter part of the training periods at Cambridge and New Haven, and later at Gales Ferry immediately before the race. They were undertaken primarily to secure data regarding the food requirements of men performing severe muscular work. Few statistics of the dietaries of persons thus engaged are available, and for this reason the results of this investigation are of especial interest. The regular course of diet and exercise pursued by boat crews in training and the conditions under which the men live at such times afford favorable opportunity for securing reliable data.

At the instigation of the Harvard athletic committee, through Dr. E. A. Darling, an investigation by Prof. W. O. Atwater and Dr. F. G. Benedict was carried on in order to obtain information regarding the food consumed and digested by the Harvard crew. This investigation was made with four members of the crew while at Gales Ferry during the last days of training previous to their race with Yale in June, 1900. The samples of food and the feces and urine were analyzed in the chemical laboratory of Wesleyan University.

The data obtained include the amounts and composition of the food eaten and of the solid and liquid excreta during the same period. The investigation thus includes a dietary study, a digestion experiment, a study of the excreta, and a nitrogen metabolism experiment. The results indicate that the four ate per man about as much as the Harvard and Yale crews in 1898, and that their food contained about 50 per cent more protein and 16 per cent more energy than that of men at ordinary occupation in the United States whose dietaries have been studied. They also digested their food just about as completely as the average man does.

Under the direction of Professor Atwater a study was made in 1900–1901 of the dietaries of ten students boarding at one of the large refectories at Harvard University, by Mr. Edward Mallinckrodt, jr., with the cooperation of Prof. C. R. Sanger. Most of the students under observation were obliged to live economically, and the amount of money spent for food by them was quite limited. The studies were carried on during three periods of three weeks each—one in the late fall, one in winter, and one in late spring. Records of the physical condition of the subjects were made during each experimental period. The data of the investigation, which have not yet been published, will, it is expected, serve as an important contribution to the subject of food consumption of persons of sedentary habits.

The investigations with the Harvard and Yale University crews in

1898 were published in Office of Experiment Stations Bulletin No. 75, Dietary Studies of University Boat Crews, by W. O. Atwater and A. P. Bryant.

MINNESOTA.

The investigations in this State have been carried on in cooperation with the University of Minnesota and the State Agricultural Experiment Station by Prof. Harry Snyder. The principal lines followed have been the study of losses in cooking vegetables and in baking bread, and a study of the composition and digestibility of bread made from wheat milled in different ways. The investigations were begun in 1895 and are still in progress.

LOSSES IN COOKING VEGETABLES.

Professor Snyder made a study of the losses in nutritive material during the boiling of potatoes, carrots, and cabbage, and found that, unless care were taken, the loss in this way might amount to a considerable percentage of the total nutrients present. The investigations in this particular line were not continued.

LOSSES IN BAKING BREAD.

This investigation belongs to a series of inquiries into the nutritive value, digestibility, and economy of cereals and cereal products and foods prepared from them. The study included an investigation of the loss of dry matter, carbon as carbon dioxid, alcohol or other volatile compounds, loss of nitrogen, changes in the solubility of the fat, and possible loss. Of the conclusions reached, perhaps the most important is that "when special care was taken in bread making the analysis of flour of the bread showed an average loss of 1.58 per cent of the total dry matter of the flour." It is to be inferred that this loss might be at times materially larger.

DIGESTION EXPERIMENTS WITH BREAD.

These have included a large number of experiments upon bread made from different kinds and grades of flour, and with different proportions of protein and starch. The results of 31 experiments have already been published and others await publication. During the prosecution of these studies a large number of analyses of different grades of flour and bread and of excretory products have been made. A large amount of this investigation is carried on coordinately with a similar investigation in Maine, under the direction of Professor Woods.

In view of the continuance of the experiments we would hardly be warranted in drawing definite conclusions from the results thus far obtained. The indication, however, is that there is little difference in

the nutritive value of fine or patent roller process, entire wheat, and Graham flour. Although the two latter kinds contain rather more protein than the patent flour, this protein is rather less digestible, so that the quantity of protein actually available in the flour per pound does not vary greatly in the different grades.

Professor Snyder also made experiments upon the relative digestibility of large and small rations. It was found that a ration which was probably insufficient for the physiological needs of the subject was slightly more completely digested than a larger ration. One experiment was made on the digestibility of potatoes in a simple diet.

MISCELLANEOUS TOPICS.

In the prosecution of the investigations a number of minor points have been considered. Among these are the production of acids and of soluble carbohydrates in bread making, the behavior of the proteids of the wheat flour and other products; the quality of bread as affected by increasing or diminishing the proportion of starch in the flour; the effect of cold and warm flours in bread making; the influence of prolonged heating of flour upon the quality of bread; the effect of blending—i. e., mixing various grades of flours—upon the quality of bread, and various minor topics connected with the analytical and experimental methods.

PUBLICATIONS.

The results of these investigations are reported in the following publications of the Office of Experiment Stations: Bul. No. 43, Losses in Boiling Vegetables and the Composition and Digestibility of Potatoes and Eggs, by H. Snyder, Almah J. Frisby, and A. P. Bryant. (The material also included in this bulletin reported by Dr. Frisby and Mr. Bryant was descriptive of similar experiments carried on at Middletown, Conn.) Bul. No. 67, Studies on Bread and Bread Making, by H. Snyder and L. A. Voorhees. (The portion of this bulletin reported by Mr. Voorhees has to do with results of similar experiments carried on in New Jersey.) Bul. No. 101, Studies on Bread and Bread Making at the University of Minnesota in 1899 and 1900, by Harry Snyder.

MISSOURI.

Investigations in this State were carried on at the University of Missouri by H. B. Gibson with the cooperation of S. Calvert and D. W. May. The investigations were concluded at the end of a year by the untimely death of Professor Gibson. Two dietary studies of student clubs were reported and an investigation of the relative bread and meat consumption by families in the State of Missouri. The results of the dietary studies are of interest in adding data to our knowledge

of the food consumption of students' clubs. The investigation as to the relative consumption of different kinds of bread and meat showed that the consumption of pork was relatively larger and beef less in farmers' families than in families living in cities or large towns. The consumption of bread, however, did not differ materially in the two cases.

The results of this investigation are published in Bulletin No. 31 of the Office of Experiment Stations: Dietary Studies at the University of Missouri in 1895 and Data relating to Bread and Meat Consumption in Missouri, by H. B. Gibson, S. Calvert, and D. W. May, with comments by W. O. Atwater and C. D. Woods.

NEW JERSEY.

Investigations in this State were carried on at the New Jersey Agricultural Experiment Station by Prof. E. B. Voorhees, and afterwards by Mr. L. A. Voorhees. These investigations were begun in 1895–96, and continued until 1897–98. The lines of inquiry were the cost and composition of milk and bread in New Jersey, studies of relative cost of bread and raw ingredients from which it was made, and losses in baking bread; one dietary study was also made. The investigations include the analyses of a large number of samples of food materials.

THE COST AND COMPOSITION OF MILK AND BREAD.

These studies were carried on in various cities and towns in New Jersey and showed that the cost of milk and bread in New Jersey compared favorably with that in other States. There was, however, no relation found between the cost of these products and their composition, it frequently happening that the milk costing the most might be one of the lowest in nutritive value.

Several studies were made of the cost of raw ingredients used in baking bread and the price at which the bread was sold. The conclusions derived were that it must depend upon the consumer himself to determine whether it is more economical to purchase bread or purchase flour and other materials and incur the necessary expense involved in baking bread at home.

LOSSES IN BAKING BREAD.

A considerable number of experiments were made determining the losses in nutritive value during the process of bread making. The conclusions reached were that this loss can hardly be considered an important factor; little if any loss was found in carbohydrates, and the apparent loss of fat is thought to be largely due to mechanical inclosure of the fat particles during the process of baking, which affects the analysis but not the nutritive value.

DIETARY STUDIES.

The investigations in New Jersey include but one dietary study, and the results must be taken in connection with those of many other dietary studies before any conclusions can be drawn.

PUBLICATIONS.

The results of the investigations in this State have been published in the following bulletins of the Office of Experiment Stations: Bul. No. 35, Food and Nutrition Investigations in New Jersey in 1895 and 1896, by Edward B. Voorhees; Bul. No. 67, Studies on Bread and Bread Making, by Harry Snyder and L. A. Voorhees (only the latter part of this bulletin is devoted to the results of the nutrition investigations in New Jersey; the first part reports results of similar experiments made in Minnesota). Besides results published in these bulletins there are a few which still await publication.

NEW MEXICO.

Investigations in this Territory were made at the New Mexico College of Agriculture and Mechanic Arts and the Agricultural Experiment Station by Prof. Arthur Goss. The work was begun in the fiscal year 1895–96, and was continued two years. The lines of inquiry were the study of food consumption of native Mexican families, a study of the composition of native food materials, and especially native beef.

DIETARY STUDIES.

Dietary studies were carried on with four Mexican familes—three of them quite poor and one in more moderate circumstances. The results are of interest in showing that these people obtained approximately the average amount of nutrients and energy found in diets of persons with similar degrees of muscular activity, at a very small cost. The average cost per man per day was 7 cents. Many of the food materials used in these studies were quite different from those found in general use in this country.

STUDY OF THE COMPOSITION OF MEXICAN FOOD MATERIALS.

This line of inquiry involved the analyses of a considerable number of food materials used by native Mexicans as well as food materials in general use by all classes in that section. In addition to these analyses a side of a range steer raised in New Mexico was analyzed.

All of the analyses of meat showed an unusually small proportion of fat as compared with the average of similar cuts in meats grown in other sections of the United States, and especially those grown and fattened in Illinois and neighboring States. The proportion of protein, however, was not greatly different from that in average beef.

PUBLICATIONS.

The results of investigations are published in the following bulletins of the Office of Experiment Stations: Bul. No. 40, Dietary Studies in New Mexico in 1895, by Arthur Goss; Bul. No. 54, Nutrition Investigations in New Mexico in 1897, by Arthur Goss.

NEW YORK.

Investigations in this State have been carried on in cooperation with the New York Association for the Improvement of the Condition of the Poor and the New York Christian Alliance. The investigations have been quite largely confined to a study of the actual food consumption of families living in the congested districts of New York City, and have been carried on largely through the aid and cooperation of Dr. Isabelle Delaney. Dr. R. L. Slagle assisted at the outset and the investigation was under the immediate supervision of both Professor Atwater and Professor Woods. The work began in 1895 and continued until 1898. The results of the study have been of considerable value in showing the actual food consumption of persons with limited means. As a general thing the families were well nourished, but there was evident lack of knowledge of the nutritive value of food evinced in their purchases in many cases. An equal abundance of nutriment could have been obtained at a much reduced cost.

Some analyses of food materials were made at Middletown, Conn., in connection with this investigation, and all of the work of computations was likewise carried on at that place.

Sixty-two dietary studies have been made. Of these, results of 26 were published in Bulletin No. 46 of the Office of Experiment Stations: Dietary Studies in New York City in 1895 and 1896, by W. O. Atwater and C. D. Woods. The results of the remaining studies will, it is expected, soon be published.

In addition to the investigations just mentioned, Dr. H. C. Sherman, of Columbia University, formerly associated with the nutrition investigations in Middletown, Conn., is engaged in an abstract research concerning the metabolism of phosphorus and sulphur in the human body. Much of the actual work of investigation is carried on in the summer at Middletown, Conn. None of the results of this latter investigation has as yet been published.

Acting under a special authorization, Mrs. Louise E. Hogan studied the growth and present status of the teaching of cookery in the public schools of New York City. Her report also includes sample lessons, which show the course followed and gives examples of the exercises, both compositions and drawings prepared by the pupils. The report is prefaced by an introduction by Director A. C. True, and is published as Bulletin No. 56, History and Present Status of Instruction in Cooking

in the Public Schools of New York City, by Mrs. Louise E. Hogan, with an introduction by H. C. True, Ph. D.

NORTH DAKOTA.

During the fiscal year 1895–96 investigations were carried on at the North Dakota Agricultural College by Prof. E. F. Ladd, assisted by Miss Marie B. Senn. The investigation included a study of the food consumption of a club of young women students and a study of break and bread making. The latter investigation was not published in the bulletins of the Department. The results of the dietary study will be found in Bulletin 91 of the Office of Experiment Stations: Nutrition Investigations at the University of Illinois, North Dakota Agricultural College, and Lake Erie College, Ohio, 1896–1900, by H. S. Grindley and J. L. Sammis, E. F. Ladd, and Isabel Bevier and Elizabeth C. Sprague. (The work by Professor Ladd forms the second article of this bulletin.)

OHIO.

In cooperation with Lake Erie College, at Painesville, Ohio, dietary studies were made of women students in 1899–1900. The work was carried on by Prof. Isabel Bevier and Miss Elizabeth Sprague, who at that time were officially connected with the institution. Valuable assistance was rendered by President Mary Evans and Dean Luett P. Bently. The work, which was carried on during the fiscal year 1899–1900, consisted of a study of the food consumption of the young women at the commons, or boarding club, of the college. The object of the study was twofold. In the first place there was the desire to obtain data concerning the food consumption of young women students. In the second place there was the purpose to provide an appetizing and nutritious diet at a cost not exceeding 25 cents per woman per day. The taste of the students and the possibilities and limitations of the food supply were studied for some six weeks before the beginning of the dietary study proper, and an idea was thus obtained regarding the character of the dishes with which there was the least table and kitchen waste. The results of the study, together with a discussion of the results and a comparison with results of similar studies made elsewhere, are reported in Bulletin 91 of the Office of Experiment Stations: Nutrition Investigations at the University of Illinois, North Dakota Agricultural College, and Lake Erie College, Ohio, 1896–1900, by H. S. Grindley and J. L. Sammis, E. F. Ladd, and Isabel Bevier and Elizabeth C. Sprague.

PENNSYLVANIA.

The Department cooperated with the Pennsylvania College for Women, located at Pittsburg, in a series of investigations carried on by Miss Isabel Bevier, at that time professor of natural sciences in

the institution named. Six dietary studies—one of a professional man's family, four of mechanics' families, and one of a laborer's family—were reported, as well as a study of the composition and cost of bakers' bread in Pittsburg and the composition of bread in relation to the changes which the materials undergo in baking. In conducting this investigation, Miss Bevier was aided by the directors of Kingsley House, a college settlement of Pittsburg. Miss L. P. Meloy and Miss E. R. Evans rendered much assistance in the practical details of the work. The investigations were published as Bulletin No. 52, Nutrition Investigations in Pittsburg, Pa., 1894–1896.

TENNESSEE.

Investigations in this State have been carried on in cooperation with the University of Tennessee by Prof. Charles E. Wait. Professor Wait has had the assistance of Messrs. C. O. Hill, J. O. La Bach, C. A. Mooers, W. H. Gildersleeve, and W. K. Hunter. Valuable assistance at the beginning of the work was rendered by Mr. H. M. Smith, then of Middletown, Conn. The work was begun in 1898, and is being continued at the present time.

DIETARY STUDIES.

Eleven dietary studies were carried on in connection with these investigations—three of college students' clubs and two in mechanics' families and six among families of mountaineers. The results of these latter studies have not yet been published. The results of the dietary studies are of much interest in themselves and are especially valuable when taken in connection with those of similar studies made in other parts of the United States.

DIGESTION EXPERIMENTS.

A large number of digestion experiments have been made by Professor Wait, 21 of these having to do simply with the digestibility either of single food materials or of food of more or less mixed diet. A large number of digestion experiments have been made in connection with studies of the effect of muscular work upon the digestibility of food and the metabolism of nitrogen.

In an average of 47 digestion experiments carried on for the purpose of studying the effect of muscular work upon digestion and nitrogen metabolism practically no difference was found in the proportions of nutrients and energy digested when the subjects were at rest and at work. Neither was there found any noticeable effect of the work in increasing nitrogen metabolism. A large number of similar experiments still await publication. The results of these bear out the results already published and indicate that a moderate amount of muscular work does not noticeably affect the digestion, nor does it cause increased metabolism of nitrogen when there is sufficient energy in the diet.

COMPOSITION OF TENNESSEE FOOD MATERIALS.

A large number of analyses of food materials have been made in connection with these investigations, nearly all of which are of distinctively Tennessee products. They included, besides the analysis of a large number of cuts of Tennessee-grown beef, analysis of a side of Tennessee beef, a side of Tennessee-raised mutton, and the composition of the flesh of 20 chickens. The conclusions from these analyses are that both beef and mutton raised in Tennessee are, as a rule, less fat than similar meats from cattle raised and fattened in the central and western parts of the country. The composition of chicken did not vary greatly from that of chicken raised elsewhere.

PUBLICATIONS.

Such of the results of investigations in Tennessee as are already published will be found in the following bulletins of the Office of Experiment Stations: Bul. No. 29, Dietary Studies at the University of Tennessee in 1895, by Chas. E. Wait; Bul. No. 53, Nutrition Investigations at the University of Tennessee in 1896 and 1897, by Chas. E. Wait; Bul. No. 89, Experiments on the Effect of Muscular Work upon the Digestibility of Food and the Metabolism of Nitrogen, conducted at the University of Tennessee, 1897–1899, by Chas. E. Wait.

VERMONT.

Investigations in this State are being carried on at the present time by Prof. J. L. Hills, of the Agricultural Experiment Station, the special objects being to study the dietaries of farmers' families and to determine the proportion of total nutrients furnished by dairy products. The results obtained up to the present time await publication.

VIRGINIA.

The first of the investigations in this State was made with the cooperation of the State University. Prof. J. W. Mallett carried on a number of studies regarding the physiological effect of creatin and creatinin, the nitrogenous materials which constitute the so-called meat bases—that is, the principal materials which are extracted when meat is boiled. It was found that these materials do not serve as nutrients for the body. The results were published in Bul. No. 66 of the Office of Experiment Stations, on The Physiological Effect of Creatin and Creatinin and Their Value as Nutrients, by J. W. Mallet.

Cooperating with the Hampton Normal and Agricultural Institute, dietary studies were made of negroes in eastern Virginia in 1897–98 by H. B. Frissell, principal of this institution, assisted by W. F. Schultz, and in another locality of the same region of Virginia by Miss Isabel Bevier, under a special authorization from the Department of Agriculture. Many of the families had very limited means

and little education. Some, however, had been under the influence of Hampton Institute, and the effect of education as shown by the improvement in their dietary habits was marked.

Of particular interest in these studies is the influence of the proximity to salt water upon the diet of the negro families. Fish formed an important part of their diet, replacing to a certain extent the bacon of the Alabama negro. In this way the protein in the diet was much larger than in the dietary studies in Alabama, approaching more nearly the average for persons under ordinary circumstances. The results of this investigation are published in Bul. No. 71 of the Office of Experiment Stations, on Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898, by H. B. Frissel and Isabel Bevier.

SOME RESULTS OF NUTRITION INVESTIGATIONS.

DIETARY STUDIES.

Among the results of general interest are those of the studies of the actual food consumption of people of different classes and in different parts of the United States. These included dietary studies in families of farmers, mechanics, and men in professional life, of people in the congested districts of the slums of New York and Chicago, of negroes in the South, of Spaniards in the extreme Southwest, and of Chinese on the Pacific coast. The following table shows the extent of the dietary investigations:

Statistics of dietary studies.

	Number of studies.	Men.	Women.	Children.	Total.
Studies made in connection with nutrition investigations.					
Families and boarding houses	176	279	262	466	1,007
Students' clubs	23	372	179	6	557
Unclassified	14	4	2	5	11
Total	213	655	443	477	1,575
Studies made by Storr's Experiment Station.					
Families and boarding houses	37	60	58	35	153
Students' clubs	5	141	62	0	203
Institutions	2	510	562	0	1,072
Unclassified	13	11	0	1	12
Total	57	722	682	36	1,440
Miscellaneous studies.					
Institutions	64	4,303	3,205	0	7,508
Students' clubs	3	63	167	0	230
Families	2	3	4	1	8
Total	69	4,369	3,376	1	7,746
Grand total	339	5,746	4,501	514	10,761

The results of the more important dietary studies thus far made are summarized in the table following, which shows the average amounts of both the total nutrients in the food consumed, as calculated from the weights and chemical composition, and the digestible nutrients as esti-

mated by the use of the coefficients of digestibility assumed from the results of digestion experiments. The fuel value represents the amount of energy of the food that is available to the body. The table also includes the dietary standards that have been proposed, taking into consideration both the data obtained in dietary studies and the results of physiological experiments.

Summarized results of dietary studies in the United States.

[Quantities per man per day.]

	Number of studies included in averages.	Actually eaten.			Digestible.			Fuel value.	Nutritive ratio.
		Protein.	Fat.	Carbohydrates.	Protein.	Fat.	Carbohydrates.		
Persons with active work.		*Grms.*	*Grms.*	*Grams.*	*Grms.*	*Grms.*	*Grams.*	*Calories.*	*1:*
Rowing clubs in New England	7	155	177	440	143	168	427	3,955	5.6
Bicyclists in New York	3	186	186	651	171	177	631	5,005	6
Football teams in Connecticut and California	2	226	354	634	208	336	615	6,590	6.6
Persons with ordinary work.									
Farmers' families	10	97	130	467	89	124	453	3,415	8.2
Mechanics' families	14	103	150	402	95	143	390	3,355	7.5
Laborers' families in large cities	12	101	116	344	93	110	334	2,810	6.3
Laborers' families in more comfortable circumstances	2	120	147	534	110	140	518	3,925	7.6
Professional men.									
Lawyers, teachers, etc	14	104	125	423	96	119	410	3,220	7.1
College clubs	15	107	148	459	98	141	445	3,580	7.8
Men with little or no exercise.									
Men in respiration calorimeter	11	112	80	305	103	76	296	2,380	4.5
Persons in destitute circumstances.									
Poor families in New York City	11	93	95	407	86	90	395	2,845	6.9
Laborers' families in Pittsburg, Pa	2	80	95	308	74	90	299	2,400	6.8
Miscellaneous.									
Negro families in Alabama	20	62	132	436	57	125	423	3,165	12.4
Negro families in Virginia	19	109	159	444	100	151	342	3,625	6.8
Italian families in Chicago	4	103	111	391	95	105	379	2,965	6.5
French Canadians in Chicago	5	118	158	345	109	150	335	3,260	6.2
Bohemian families in Chicago	8	115	101	360	106	96	349	2,800	5.3
Inhabitants of Java Village, Columbian Exposition, 1893	1	66	19	254	61	18	246	1,450	4.7
Russian Jews in Chicago	10	137	103	418	126	98	405	3,135	5
Mexican families in New Mexico	4	94	71	613	86	67	595	3,460	8.7
Chinese dentist in California	1	115	113	289	106	107	281	2,620	4.9
Chinese laundrymen in California	1	135	76	566	124	72	549	3,480	5.7
Chinese farm laborers in California	1	144	95	640	132	90	621	3,980	6.2
Fruitarians	6	50	102	237	43	92	225	2,055	10
Dietary standards.									
Man with very hard muscular work (Atwater)	.....	175	([a])	([a])	161	([a])	([a])	5,500	7.2
Man with hard muscular work (Atwater)	.....	150	([a])	([a])	138	([a])	([a])	4,150	6.2
Man with moderately active muscular work (Atwater)	.....	125	([a])	([a])	115	([a])	([a])	3,400	6.2
Man with light to moderate muscular work (Atwater)	.....	112	([a])	([a])	103	([a])	([a])	3,050	6.1
Man at "sedentary" or woman with moderately active work (Atwater)	.....	100	([a])	([a])	92	([a])	([a])	2,700	6.1
Woman at light to moderate muscular work (Atwater)	.....	90	([a])	([a])	83	([a])	([a])	2,450	6.1

[a] Fats and carbohydrates in sufficient amounts to furnish, together with the protein, the indicated amount of energy.

The main outcome of these investigations of the amount of food consumed may be expressed in two statements. The differences in diet are in part such as would commonly come with the differences in the actual food supply in the markets, but they are influenced, to some extent, by race habits, and, to a still larger extent, by the material conditions of the consumer, including, especially, the income. The number of the insufficiently fed in the poorest parts of New York and Chicago is smaller than one would naturally suppose. The common opinion of physicians that a great many well-to-do people eat more than is best for their health is confirmed by comparison of the dietary studies with the commonly accepted standards of physiological demand.

The studies thus far made of the negroes and of the whites of the poorer class entirely confirm the general impression that the staple products are corn meal, pork, and molasses. The quantity of protein in such a diet is far below what is commonly believed by physiologists to correspond to the normal demand. The practical consensus of physiologists is that one thing greatly needed for the improvement of the material condition of these two large bodies of our fellow-citizens is a diet which will supply more protein. Fortunately this is entirely possible. It can be brought about by the more general use as food of leguminous plants, as the cowpea, and of home-grown beef.

It is interesting to note that the few dietary studies thus far made of the Chinese on the Pacific coast, who are supposed to have very much the same food as they do at home, contains a liberal amount of protein. This is contrary to the common opinion that the food of the Chinese consists mainly of rice and is especially deficient in protein.

One of the interesting results of the observation of the food of the people of the congested districts in New York and Chicago is that the errors in the dietary are due more to ignorance and the lack of wise economy than to lack of money.

WAYS IN WHICH THE RESULTS OF DIETARY STUDIES MAY BE USED.

Some of the more important and more noticeable results of dietary studies have been noted in the preceding paragraphs. How can these results be applied to the benefit of the individual, the class, or the human race? There are many ways in which this can be done. Perhaps one of the most important of these is in instruction concerning the nutritive value of the different food materials and their pecuniary economy. People should be taught how to improve their diet by the economical purchase of food materials best adapted to their physical needs. It will be found that by exercising care in the purchase and preparation of food a palatable and relatively inexpensive diet may often be obtained. Much is already being done along this line in many of the large cities, where the cost of many food materials must always be relatively high.

When the true character of the different kinds of food materials is more thoroughly understood diet will almost of necessity become more rational. With the advance of knowledge as to the physical requirements of the body it will become possible to establish standards which shall indicate the approximate amount of the different nutrients required. By this it is not to be understood that any definite rules for the consumption of food can be laid down, but simply that it will be possible to furnish a reliable guide for the purchase and use of foods.

The proper nourishment of the inmates of institutions where large numbers must be fed, such as schools, reformatories, prisons, and hospitals, is a subject that is attracting no little attention at the present time. In several instances studies have been made of the actual food consumption in such institutions, and quite recently an extended study of the food requirements of the insane has been carried on by one of the States. In many instances dietary studies have been made in schools, college clubs, etc., and the information obtained has been of much use. That such studies have been found to have a practical value and that the interest in them is widespread is shown by the fact that a considerable number have been undertaken by instructors and others interested, aside from those carried on by the Department of Agriculture.

When it so happens that large bodies of men are to be fed, as in the case of armies, or where the transportation of large amounts of food is difficult, the results obtained from dietary studies and similar investigations are of the utmost advantage in the selection of the food ration. It also becomes possible to select condensed rations which for emergencies shall furnish within the smallest space sufficient food for sustenance.

These are some of the more important uses that can be made of the results of dietary studies and similar investigations. They are sufficient to show the advantage to be obtained from extended research in this direction. At present only a beginning has been made, but every year adds to the data available.

In general, the object of dietary studies is not to limit the amount or variety of food to be used by the people, but rather to discover ways and means in which their dietaries may be improved and the available food supply be most economically used to maintain the body in good health and to make it an efficient instrument for the different forms of labor required by our complex civilization.

It is not the purpose of food chemists to prescribe weighed amounts of different foods as a physician prescribes medicines, but rather to show the actual nutritive value of different food materials and their relative economy as sources of nutrients, leaving the application of the knowledge to individuals. Although dietary standards are suggested, it is not necessary that the food each day should contain exactly

the kind and amounts of the different nutrients required by the standards. A slight deficiency one day will be made good by an excess the next, the body serving as a storehouse for reserve material. Experience has, however, shown that the body is best nourished when through long periods the food approximates the requirements of the so-called standards. Individual requirements and individual peculiarities will always affect the choice of foods. In the purchase of other things their value for the purpose for which they are intended is considered as well as their cost. Without doubt the same principle may be advantageously applied to the purchase of food. By the exercise of a wise economy, based on a knowledge of the real nutritive value of foods, a more satisfactory diet can be obtained for a less sum than is at present expended in many cases, or the cost of the diet may be diminished without lessening its nutritive value.

COMPOSITION OF FOOD MATERIALS.

One outcome of the nutrition investigations is that we have to-day a tolerably clear knowledge of the composition and nutritive values of our ordinary American food materials. Taking into account not only the results of analyses but also of digestion experiments, we are able to prepare tables showing the average quantities of digestible nutrients in a large number of the food materials in most common use. The table herewith is an illustration of this:

Nutrients and energy of digestible portion of some common foods, with nutritive ratios.

Kind of food materials.	Refuse.	Water.	Total indigestible nutrients.	Digestible nutrients.				Fuel value per pound.	Nutritive ratio.
				Protein.	Fat.	Carbohydrates.	Ash.		
ANIMAL FOOD.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*	*1:*
Beef, fresh:									
Chuck, ribs	16.3	52.6	1.4	15	14.3	....	0.6	910	2.1
Loin, medium	13.3	52.5	1.6	15.6	16.6	....	.7	1,025	2.4
Ribs	20.8	43.8	1.8	13.5	20	....	.5	1,135	3.3
Round, medium	7.2	60.7	1.4	18.4	12.2	....	.8	890	1.5
Shoulder and clod	16.4	56.8	1.2	15.9	9.3	....	.7	715	1.3
Beef, dried and smoked	4.7	53.7	4.5	25.6	6.6	....	5.5	790	.6
Veal:									
Cutlets, round	3.4	68.3	1.2	19.5	7.1	....	.8	695	.8
Leg	14.2	60.1	1.1	15	7.5	....	.7	625	1.1
Mutton:									
Leg	18.4	51.2	1.4	14.6	14	....	.6	890	2.2
Loin	16	42	2	13.1	26.9	....	.5	1,415	4.6
Pork, fresh:									
Loin, chops	19.7	41.8	1.8	13	23	....	.6	1,245	4
Ham	10.7	48	1.9	13.1	24.6	....	.6	1,320	4.2
Pork, salted and smoked:									
Bacon	7.7	17.4	4.4	8.8	59.1	....	3.1	2,720	15.1
Ham	13.6	34.8	3.1	13.8	31.7	....	3.2	1,635	5.2
Salt, fat	....	7.9	5.4	1.8	81.9	....	2.9	3,555	....
Poultry:									
Fowl	25.9	47.1	1.2	13.3	11.7	....	.5	765	2
Turkey	22.7	42.4	1.6	15.6	17.5	....	.6	1,060	2.5
Fish, fresh:									
Cod, dressed	29.9	58.5	.5	10.8	.2	....	.6	220	.1
Mackerel	44.7	40.4	.7	9.9	4	....	.5	370	.9

Nutrients and energy of digestible portion of some common foods, etc.—Continued.

Kind of food materials.	Refuse.	Water.	Total indigestible nutrients.	Digestible nutrients. Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.	Nutritive ratio.
ANIMAL FOOD—continued.									
Shellfish:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*	1:
Oysters, solids	....	88.3	0.6	5.8	1.2	3.3	0.8	225	1
Fish, preserved and canned:									
Cod, salt	24.9	40.2	5.1	15.5	.4	....	13.9	325	.1
Salmon, canned	....	63.5	1.9	21.1	11.5	....	2	915	1.2
Eggs, uncooked	11.2	65.5	1.1	12.7	8.8	....	.7	635	1.7
Dairy products:									
Whole milk	....	87	.5	3.2	3.8	5	.5	310	4.3
Skim milk	....	90.5	.3	3.3	.3	5.1	.5	165	1.8
Cream	....	74	1.1	2.4	17.6	4.5	.4	865	18.4
Butter	....	11	4.9	1	80.8	....	2.3	3,410	....
Cheese	....	34.2	3.4	25.1	32	2.4	2.9	1,880	3
VEGETABLE FOOD.									
Cereals, etc.:									
Corn meal	....	12.5	3.3	7.8	1.7	73.9	.8	1,640	10
Oat breakfast food	....	7.8	5.1	14.2	6.6	64.9	1.4	1,800	5.6
Rye flour	....	12.9	2.9	5.8	.8	77.1	.5	1,620	13.6
Rice	....	12.3	2.9	6.8	.3	77.4	.3	1,625	11.5
Wheat flour, patent process	....	12	3.4	9.7	.9	73.6	.4	1,635	7.8
Wheat breakfast food	....	9.6	3.8	10.3	1.6	73.7	1	1,680	7.5
Bread, etc.:									
Bread, white wheat	....	35.3	2.9	7.8	1.2	52	.8	1,200	7
Crackers, cream	....	6.8	4.5	8.2	10.9	68.3	1.3	1,925	11.3
Vegetables:									
Beans, white, dried	....	12.6	7.9	17.5	1.6	57.8	2.6	1,520	3.5
Beets, fresh	20	70	.8	1.1	.1	7.3	.7	160	6.8
Cabbage	15	77.7	.6	1.2	.2	4.6	.7	115	4.2
Potatoes	20	62.6	1.2	1.5	.1	14	.6	295	9.5
Squash	50	44.2	.4	.6	.2	4.3	.3	100	7.8
Sweet potatoes, fresh	20	55.2	1.6	1.2	.5	20.8	.7	440	18.3
Tomatoes	....	94.3	.5	.7	.4	3.7	.4	95	6.6
Fruits:									
Apples	25	63.3	1.2	.3	.3	9.7	.2	190	34.7
Bananas	35	48.9	1.6	.7	.4	12.9	.5	260	19.7
Grapes	25	58	1.7	.9	1.1	13	.3	295	17.2
Oranges	27	63.4	1	.5	.1	7.7	.3	150	15.8
Strawberries	5	85.9	1	.8	.5	6.3	.5	150	9.3

The inquiries regarding the composition, digestibility, and nutritive values of bread made from different milling products of wheat have already given valuable results. These are being carried on in one Eastern State, Maine, where considerable wheat is grown and milled, and more especially, in Minnesota, in the midst of the wheat region of the Northwest. The facilities of some of the great flouring mills at Minneapolis have been made available by the proprietors for grinding large quantities of wheat of different types, the grinding being done so as to produce from the same lot of wheat the so-called graham flour, which contains nearly the whole of the grain of the wheat, the so-called whole-wheat flour, which contains nearly all but the outer portion of the kernel, and different grades of white flour from which the brans have been separated. These different kinds of flour have been made into bread and the digestibility of the different kinds of bread has been tested by actual experiments with healthy men. The outcome may be briefly stated as follows:

According to the chemical analysis of graham, entire-wheat, and

standard patent flours milled from the same lot of hard Scotch Fife spring wheat, the graham flour contained the highest and the patent flour the lowest percentage of total protein. But according to the results of digestion experiments with these flours the proportions of digestible or available protein and available energy in the patent flour were larger than in either the entire-wheat or the graham flour. The lower digestibility of the protein of the latter is due to the fact that in both these flours a considerable portion of this constituent is contained in the coarser particles (bran), and so resists the action of the digestive juices and escapes digestion. Thus while there actually may be more protein in a given amount of graham or entire-wheat flour than in the same weight of patent flour from the same wheat, the body obtains less of the protein and energy from the coarse flour than it does from the fine, because, although the including of the bran and germ increases the percentage of protein, it decreases its digestibility. By digestibility is meant the difference between the amounts of the several nutrients consumed and the amount excreted in the feces.

The digestibility of first and second patent flours was not appreciably different from that of standard patent flour. The degree of digestibility of all of these flours is high, due largely to their mechanical condition—that is, to the fact that they are finely ground.

These results are in accord with other accurate investigations, but their especial value lies in the fact that the experimental inquiry has been more thorough and extensive than any previously reported. The disparity between the conclusions just quoted and much of the popular belief, current newspaper statements, and, indeed, some of the teaching in physiological text-books, illustrates the importance of having such problems carefully studied.

METABOLISM EXPERIMENTS WITH THE RESPIRATION CALORIMETER.

From the more purely scientific standpoint, the interest of this nutrition inquiry culminates in the experiments with the respiration calorimeter. These have for their object the study of the transformations of matter and energy in the living organism. In other words, they represent an inquiry into the most fundamental and most important laws of nutrition. The apparatus used for the purpose is the Atwater-Rosa respiration calorimeter described on page 447.

The most important result thus far obtained by the use of this apparatus is what amounts practically to a demonstration that the law of the conservation of energy applies to the living organism. It has long been known that this law obtains in the inorganic world. The proof that this law obtains in the inorganic world was one of the great scientific achievements of the last century. It has, of course, been assumed and very generally believed that it must apply in the organic world, in the living being also, but a complete and satisfactory demonstration has not hitherto been made, although an approximation was found in

a number of European experiments with dogs. It would perhaps be going too far to say that the experiments with the respiration calorimeter by Professor Atwater and his associates at Wesleyan University have sufficed for the absolute and final proof, but certainly the results leave scarcely any room for doubt. As the outcome of 44 experiments with five different men, covering a period of 134 days, the ratio of the potential energy of the material oxidized in the body to the energy given off from the body in the forms of heat and muscular work, as measured by the respiration calorimeter, is as 1,000 to 999. The same ratio of 1,000 to 999 was found in the average of a number of experiments made to test the accuracy of the apparatus. Closer agreement than this could not be looked for.

The practical usefulness of this apparatus and method of inquiry will be realized more clearly when we consider that it gives us a means for measuring so accurately the transformations of both material and energy. It may be said also that the measurements of the income and outgo of material are nearly as accurate as those of energy. We have thus the means for studying the effects of different diets, different kinds and amounts of food in the body, the effects of different forms of work and of rest upon the consumption of material, the nutritive values of different food materials, and are thus enabled to get at the very foundations of the doctrine of nutrition.

FACTORS FOR DIGESTIBILITY AND FUEL VALUE OF NUTRIENTS.

The data obtained in the nutrition investigations may be used in deducing certain factors which are useful in various ways to students and investigators of similar problems, and to some extent also to those who wish to make practical application of the results. These factors are epitomized in the following table:

Factors for digestibility and fuel value of nutrients of food materials.

Classes of food materials.	Protein.			Fat.			Carbohydrates.			Energy proportion of total actually available.
	Proportion of total in mixed diet.	Digestibility.	Fuel value per gram.	Proportion of total in mixed diet.	Digestibility.	Fuel value per gram.	Proportion of total in mixed diet.	Digestibility.	Fuel value per gram.	
	Per ct.	*Per ct.*	*Calories.*	*Per ct.*	*Per ct.*	*Calories.*	*Per ct.*	*Per ct.*	*Calories.*	*Per ct.*
Meats and fish	43	97	4.25	56	95	9.00	......	......	......	87
Eggs	6	97	4.35	4	95	9.00	......	......	......	89
Dairy products	12	97	4.25	32	95	8.80	5	98	3.80	93
Animal food (of mixed diet)	61	97	4.25	92	95	8.95	5	98	3.80	89
Cereals	31	85	3.70	8	90	8.35	55	98	4.10	91
Legumes (dried)	2	78	3.20				1	97	4.05	83
Sugars	......	......	......				21	98	3.85	98
Starches	......	......	......				......	98	4.10	98
Vegetables	5	83	2.90				13	95	4.00	91
Fruits	1	85	3.15				5	90	3.60	88
Vegetable food (of mixed diet)	39	85	3.55	8	90	8.35	95	97	4.00	92
Total food (of mixed diet)	100	92	4.00	100	95	8.90	100	97	4.00	91

The factors in the first, fourth, and seventh columns show what proportion of the total protein, fats, and carbohydrates in the average mixed diet is furnished by the food materials included in the different groups indicated. Those in the second, fifth, and seventh columns indicate the proportions of the different ingredients in the food materials of the various groups that are digestible when eaten in mixed diet. Those in the third, sixth, and ninth columns show how much energy the body will derive from one gram of each of the food materials included in the different groups, while the last column in the table shows what proportion of the total amount of energy in the food materials of the different classes will be utilized by the body.

With the exception of some important European determinations of heats of combustion, the data on which these factors are based are from late investigations in the United States. These include over 4,000 analyses of food materials; about 350 dietary studies; nearly 300 digestion experiments, mostly with men; several thousand determinations of heats of combustion of food materials and excretory products, and 30 experiments, continuing ninety-three days, with men in the respiration calorimeter, besides a considerable number of other experimental inquiries, including especially the determinations of the constitution of protein compounds in various materials. The results of computations by means of these factors have been found to agree very closely with those obtained in actual experiments, showing that the factors are reasonably accurate.

THE EDUCATIONAL INFLUENCE OF THE NUTRITION INVESTIGATIONS.

If the practical usefulness of these investigations is important, the educational influence is no less so. This is manifesting itself in a number of ways, but most of all in the bringing of the results of the inquiry directly into schools. Taking all the public schools and colleges in the country together, the number in which the results of these inquiries are being directly taught is relatively small. Nevertheless, the actual number of institutions in which teachers are including more or less of the outcome in their courses of instruction, especially in physiology, is already large, and growing with most encouraging rapidity. It has been the policy of the Department to deal very generously with schools and with teachers in the distribution of nutrition publications. Not only in cities, but in rural districts the schools manifest a large and rapidly growing demand for these publications. They appear to meet an actual want—one that has been rather dimly felt hitherto, but is now taking quite definite shape. The most active call has been from teachers connected with technical schools or the technical departments of colleges and high schools. That it has been

particularly active among a large number of cooking schools is of course natural, but it is scarcely less so among schools of medicine.

That the time for the development of these inquiries is especially opportune is shown by the use made of the results in the teaching of what is called domestic economy, or household economics. This represents a pedagogic movement of greater import than many realize. The movement is coming in response to a popular aspiration, but it has the earnest support of many of our leading educators, not a few of whom are emphatic in the expression of their belief in the wisdom of the popular demand and the possibility of making such instruction very useful, especially in courses for girls and young women. Educational experience shows that a certain time is required to bring any new subject first into scientific and then into pedagogic form. The science of food and nutrition has already assumed reasonably clear and accurate scientific form and is being rapidly brought into pedagogic form.

CONCLUSION.

From modest beginnings, with the aid of private individuals, these investigations under the auspices of this Department have assumed a magnitude quite out of proportion to their actual cost. By the extensive cooperation of individuals and institutions of various kinds with this Department a large amount of valuable work is being done in a systematic way, the results of which are made available to the public. In the judgment of competent experts it is more thorough in its scientific methods, more extended in the scope and amount of investigation, and more useful in the distribution and practical application of its results than any other inquiry of the kind ever undertaken in this country or in Europe. A very recent statement by a European investigator is to the point here. Dr. P. O. Smolenski, a well-known Russian authority on these subjects, has lately published in the Russian language, as an official document, an account of the nutrition investigations above described. He details the development of the inquiry, describes the methods, and cites the principal results. In commenting upon the inquiry of this kind in the United States, he lays especial stress upon both the amount and quality, in both of which he considers that the American investigators are already in advance of those in Europe. He refers to the small amount of public money expended for the purpose, and finds an explanation of the success in cooperative effort, and says that it is due to the great energy, the expert skill, and the remarkable organizing power of Americans.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON THE FOOD AND NUTRITION OF MAN.

POPULAR PUBLICATIONS FOR GRATUITOUS DISTRIBUTION.

(Requests for these publications should be sent to the Secretary of Agriculture or to a Senator or Representative or Delegate in Congress.)

Farmers' Bulletin No. 34.—Meats: Composition and Cooking. By Chas. D. Woods. Pp. 29, figs. 4, charts 4.

This contains concise explanatory statements regarding the structure, composition, texture, flavor, and digestibility of meats; practical suggestions regarding different methods of cooking meats; and tables showing the composition and fuel value of different kinds and cuts of meat.

Farmers' Bulletin No. 74.—Milk as Food. Pp. 39, charts 2.

Treats of the nutritive value of milk, and contains suggestions as to combinations with other food materials to make well-balanced and economical dietaries.

Farmers' Bulletin No. 85.—Fish as Food. By C. F. Langworthy, Ph. D. Pp. 30.

Shows the food value of fish, the great importance of the fisheries of the United States, and the immense amount of nutritive material taken each year from the salt and fresh waters of this country.

Farmers' Bulletin No. 93.—Sugar as Food. By Mary Hinman Abel. Pp. 27.

The characteristics of cane sugar and other sorts of sugar are discussed, as well as the value of sugar as a food. The practical use of sugar in the diet of children and adults is spoken of, and general conclusions drawn as to the amount of sugar desirable in the diet and the form in which it may be consumed.

Farmers' Bulletin No. 112.—Bread and the Principles of Bread Making. By Helen W. Atwater. Pp. 39, figs. 3.

The results of a large number of experiments at the different experiment stations and at other American and foreign institutions on different problems connected with bread and bread making are summarized, as well as the information on these topics afforded by standard works. It is not the object of this bulletin to give recipes for making bread, but to explain the reason for the different steps in bread making in the light of recent investigations.

Farmers' Bulletin No. 121.—Beans, Peas, and Other Legumes as Food. By Mary Hinman Abel. Pp. 32, figs. 10.

Beans, peas, lentils, and other legumes, used fresh or dried, as articles of diet are described, and their food value as compared with other vegetables and with animal foods is discussed. The principles which govern the cooking of leguminous vegetables are treated, and statistics are given of the use of such foods and their importance in the diet.

Farmers' Bulletin No. 128.—Eggs and Their Uses as Food. By C. F. Langworthy, Ph. D. Pp. 30.

The composition of hen, duck, turkey, goose, and guinea fowl eggs is given, together with that of some egg products and egg substitutes. The bulletin discusses the food value of eggs, their flavor, digestibility, place in the diet, and related topics, as well as the preservation and marketing of eggs.

Farmers' Bulletin No. 142.—The Nutritive and Economic Value of Food. By W. O. Atwater, Ph. D. Pp. 48, charts 2.

Definitions are given of the principal terms used in discussions of food and nutrition, and the general laws of the subject are spoken of. Special attention is paid to the composition of food, dietary studies, digestibility, pecuniary economy of foods, and related topics, the text being supplemented by tables and charts. Errors in food economy are pointed out and practical suggestions made.

Circular No. 46.—The Functions and Uses of Food. By C. F. Langworthy, Ph. D. Pp. 10.

Definitions of a number of the terms used in discussing food ana a statement of some principles of nutrition. The average composition of a number of the more common American foods is quoted, as well as the commonly accepted dietary standards.

Some Results of Dietary Studies in the United States. By A. P. Bryant. Pp. 14. Reprinted from Yearbook of Department of Agriculture for 1898.

A popular article describing methods of making dietary studies and discussing the differences in the food habits of people of different occupations and conditions—such as farmers, mechanics, Mexicans, negroes, and others. Some ways in which the results of dietary studies may be made practically useful are pointed out.

Development of Nutrition Investigations of the Department of Agriculture. By A. C. True, Ph. D., and R. D. Milner, Ph. B. Pp. 16. Reprinted from Yearbook of Department of Agriculture for 1899.

An historical and statistical account of the nutrition investigations conducted under the auspices of this Department. Many references are also made to American work which antedates these investigations and to later work conducted at American universities and other institutions.

The Value of Potatoes as Food. By C. F. Langworthy, Ph. D. Pp. 16, figs. 3. Reprinted from Yearbook of Department of Agriculture for 1900.

The structure and composition of the potato are spoken of, together with the changes brought about in cooking, the digestibility, place in the diet, and related topics.

FOR SALE.

(To secure these publications, address the Superintendent of Documents, Union Building, Washington, D. C., inclosing price given. Remittances must be made by cash or United States postal order. Postage stamps and checks not accepted.)

Bulletin No. 21.—Methods and Results of Investigations on the Chemistry and Economy of Food. By W. O. Atwater Ph. D. Pp. 222, charts 3, figs. 15. Price 15 cents.

This bulletin discusses food and its uses, the composition of food materials, the digestibility of food, preparation and cooking, uses of food in the body, metabolism of energy, pecuniary economy of food, dietaries and dietary standards, and errors in food economy.

Bulletin No. 28 (revised).—The Chemical Composition of American Food Materials. By W. O. Atwater, Ph. D., and A. P. Bryant, M. S. Pp. 87, figs. 4. Price 5 cents.

This contains tables showing the maximum, minimum, and average composition and fuel value of a large number of different food materials.

Bulletin No. 29.—Dietary Studies at the University of Tennessee in 1895. By Chas. E. Wait, Ph. D., F. C. S., Professor of Chemistry, University of Tennessee. With comments by W. O. Atwater and Chas. D. Woods. Pp. 45. Price 5 cents.

An account of three dietary studies made with the college club of the University of Tennessee and one dietary study of a mechanic's family in Tennessee, with a discussion of the results.

Bulletin No. 31.—Dietary Studies at the University of Missouri in 1895, and Data Relating to Bread and Meat Consumption in Missouri. By H. B. Gibson, S. Calvert, and D. W. May, University of Missouri. With comments by W. O. Atwater and Chas. D. Woods. Pp. 24. Price 5 cents.

An account of two dietary studies made with the college club of the University of Missouri and compiled information obtained from the students of the University regarding bread and meat consumption at their homes.

Bulletin No. 32.—Dietary Studies at Purdue University, Lafayette, Ind., in 1895. By Winthrop E. Stone, Ph. D., Professor of Chemistry, Purdue University. With comments by W. O. Atwater and Chas. D. Woods. Pp. 28. Price 5 cents.

An account of dietary studies in the families of a teacher and a tinner in Indiana, with a discussion of the results.

Bulletin No. 35.—Food and Nutrition Investigations in New Jersey in 1895 and 1896. By Edward B. Voorhees, A. M., Director New Jersey Agricultural Experiment Stations. Pp. 40. Price 5 cents.

The subjects of these investigations were: (1) The composition and cost of bread in New Jersey; (2) bakery experiments; (3) the composition and cost of milk in cities in New Jersey; and (4) a dietary study. The objects of this work were to secure (1) definite data in regard to the variations in the cost per pound of bread, and (2) positive information concerning the variations that exist in the composition of bread and the relative cost per pound of the nutrients contained in it.

Bulletin No. 37.—Dietary Studies at the Maine State College in 1895. By Whitman H. Jordan, M. S., Director Maine Agricultural Experiment Station. Pp. 57. Price 5 cents.

This investigation may be termed a feeding experiment with man, as in it an attempt was made to control the sources of protein, which was furnished in cheap and in expensive forms. The influence of an abundance of milk in a dietary was also studied, and the results obtained were compared with those of a dietary study made under normal conditions. The investigation concluded five dietary studies at the college commons.

Bulletin No. 38.—Dietary Studies with Reference to the Food of the Negro in Alabama in 1895 and 1896. Conducted with the cooperation of the Tuskegee Normal and Industrial Institute, and the Agricultural and Mechanical College of Alabama. Reported by W. O. Atwater and Chas. D. Woods. Pp. 69. pls. 2. Price 5 cents.

Results of an inquiry into the food of the colored population of the Southern States, especially as regards the kinds, amounts, and composition of the food mate-

rials used. It embraces also a consideration of the hygienic and pecuniary economy of their diet, its deficiencies, the ways in which it might be improved, and the steps which should be taken to bring about an improvement.

Bulletin No. 40.—Dietary Studies in New Mexico in 1895. By Arthur Goss, M. S., Professor of Chemistry, New Mexico College of Agriculture and Mechanic Arts. Pp. 23. Price 5 cents.

An account of two dietary studies with Mexican families of limited means and one study of a family in more comfortable circumstances. The composition of a number of foods typical of this region in New Mexico is reported, and the dietary studies are discussed in relation to their environment and to results of similar studies made elsewhere.

Bulletin No. 43.—Losses in Boiling Vegetables, and the Composition and Digestibility of Potatoes and Eggs. By H. Snyder, B. S., Almah J. Frisbie, M. D., and A. P. Bryant, M. S. Pp. 31, figs. 7. Price 5 cents.

This bulletin contains three articles: The first, by H. Snyder, is entitled "The Loss of Nutrients in Boiling Potatoes, Carrots, and Cabbages," and reports a number of experiments on the losses which these vegetables undergo when boiled in different ways. The second, entitled "The Digestibility of Potatoes and Eggs," by H. Snyder, reports experiments on the digestibility of boiled eggs in pepsin solution and digestion experiments with a man on a mixed diet of which eggs were the principal constituent. The third article is entitled "The Composition of Different Parts of the Potato and the Loss of Nutrients During the Process of Boiling," by Almah J. Frisbie and A. P. Bryant, and reports the composition of different parts of the potato and experiments on the loss of nutrients when potatoes are boiled in different ways.

Bulletin No. 44.—Report of Preliminary Investigations on the Metabolism of Nitrogen and Carbon in the Human Organism with a Respiration Calorimeter of Special Construction. By W. O. Atwater, Ph. D., C. D. Woods, B. S., and F. G. Benedict, Ph. D. Pp. 64, figs. 4. Price 5 cents.

A detailed description of a respiration calorimeter suitable for experiments with man is given, and the methods and apparatus employed in the collection and analysis of the liquid, solid, and gaseous excretory products are described. Four experiments are reported in which the subjects remained in the respiration chamber for from three to twelve days. The foods and excretory products were analyzed and the balance of income and outgo of nitrogen and carbon determined.

Bulletin No. 45.—A Digest of Metabolism Experiments in which the Balance of Income and Outgo was Determined. By W. O. Atwater, Ph. D., and C. F. Langworthy, Ph. D. Pp. 434. Price 25 cents.

A compilation including 2,300 experiments with man and 1,400 with domestic animals in which the balance of income and outgo of nitrogen, or nitrogen and carbon, with or without oxygen, hydrogen, or mineral matter was determined. The experiments are classified and arranged, and the tables of results are supplemented by text in which the experiments are described, the objects sought, the experimental methods employed, and the conclusions drawn being noted in more or less detail.

Bulletin No. 46.—Dietary Studies in New York City in 1895 and 1896. By W. O. Atwater, Ph. D., and Chas. D. Woods, B. S. Pp. 117. Price 10 cents.

An account of twenty-one dietary studies of families living in the congested portions of New York City, a family at a mission, and a day nursery at a mission. From the results obtained some deductions are drawn concerning improvements in the living of such families.

Bulletin No. 52.—Nutrition Investigations in Pittsburg, Pa., 1894–1896. By Isabel Bevier, Professor of Natural Science in the Pennsylvania College for Women, Pittsburg. Pp. 48. Price 5 cents.

The investigations reported in this bulletin are: (1) Six dietary studies—one of a professional man's family and five of families of mechanics and day laborers; (2) the composition and prices of bakers' bread in Pittsburg; and (3) the composition of bread and the changes which the materials undergo in baking.

Bulletin No. 53.—Nutrition Investigations at the University of Tennessee in 1896 and 1897. By Chas. E. Wait, Ph. D., F. C. S., Professor of Chemistry in the University of Tennessee. Pp. 46, figs. 2. Price 5 cents.

The investigations reported in this bulletin are: (1) Studies of the composition of different kinds of meat, including analyses of a side of native Tennessee beef divided into seventeen cuts, according to the usage of the Knoxville market, of a side of native Tennessee mutton divided into six cuts, and of twenty Tennessee chickens, as purchased in the open market; (2) dietary studies, including two mechanics' families living in Knoxville, and two college clubs; and (3) twenty-one digestion experiments with healthy men.

Bulletin No. 54.—Nutrition Investigations in New Mexico in 1897. By Arthur Goss, M. S., Professor of Chemistry, New Mexico College of Agriculture and Mechanic Arts. Pp. 20, pl. 1, fig. 1. Price 5 cents.

This bulletin includes an analytical study of a side of New Mexico range beef which was regarded as typical. The results were compared with studies of beef raised in other regions. A dietary study of a poor Mexican family was also reported.

Bulletin No. 55.—Dietary Studies in Chicago in 1895 and 1896. Conducted with the cooperation of Jane Addams and Caroline L. Hunt, of Hull House. Reported by W. O. Atwater and A. P. Bryant. Pp. 76. Price 5 cents.

In this bulletin fifty dietary studies among children, French Canadians, orthodox Russian Jews, unorthodox Russian Jews, and Bohemians living in the thickly congested district of Chicago are reported, as well as three dietary studies of professional men living in comfortable circumstances. Results are discussed and compared with the results of dietary studies made elsewhere.

Bulletin No. 63.—Description of a New Respiration Calorimeter and Experiments on the Conservation of Energy in the Human Body. By W. O. Atwater, Ph. D., and E. B. Rosa, Ph. D. Pp. 94, pls. 8, figs. 12. Price 10 cents.

The special features of the respiration calorimeter, which have to do with the measurement of the income and outgo of energy, are described. Experiments test-

ing the accuracy of the apparatus are reported in which heat was generated inside the respiration chamber by an electric current or by burning alcohol. Two experiments with a man were also reported.

Bulletin No. 66.—The Physiological Effect of Creatin and Creatinin and their Value as Nutrients. By J. W. Mallet, M. D., LL. D., Professor of Chemistry in the University of Virginia. Pp. 24. Price 5 cents.

A number of experiments are reported. It was found that creatin and creatinin, which make up the greater part of the nitrogenous material of most meat extracts, do not serve as nutrients in the body. The creatinin is excreted unchanged, while creatin is changed wholly or very largely into creatinin.

Bulletin No. 67.—Studies on Bread and Bread Making. By Harry Snyder and L. A. Voorhees. Pp. 51, pls. 2, figs. 3. Price 10 cents.

Two separate papers are included. In the first, Professor Snyder reports the composition of a number of samples of Minnesota bread as compared with its cost; studies of the loss of dry matter, carbon, and nitrogen; the production of soluble carbohydrates and acid; the behavior of wheat proteids; and the changes in the solubility of fat during bread making. Digestion experiments with bread made from patent roller-process flour and bakers' grade flour are also included. Professor Voorhees, in the second paper, reports experiments on the loss of nutrients in bread making, noting especially the changes in the fat, and discusses his investigations in relation to the work of others along similar lines.

Bulletin No. 68.—A Description of Some Chinese Vegetable Food Materials and their Nutritive and Economic Value. By Walter C. Blasdale, Instructor in Chemistry, University of California. Pp. 48, pls. 8. Price 10 cents.

The composition of a number of vegetable food materials in common use among the Chinese on the Pacific coast of the United States is reported and their food value, etc., discussed. The vegetable products include, among other materials, lotus roots and seeds, taro, lily bulbs and flowers, cassava, lichi nuts, Chinese olives, and water chestnuts.

Bulletin No. 69.—Experiments on the Metabolism of Matter and Energy in the Human Body. By W. O. Atwater, Ph. D., and F. G. Benedict, Ph. D., with the cooperation of A. W. Smith, M. S., and A. P. Bryant, M. S. Pp. 112. Price 10 cents.

A technical bulletin reporting progress in the experiments with the respiration calorimeter. The details of six experiments with healthy men are reported, in which the balance of income and outgo of matter and energy was determined. Check experiments, designed to show the accuracy of the apparatus, are also described in detail.

Bulletin No. 71.—Dietary Studies of Negroes in Eastern Virginia in 1897 and 1898. By H. B. Frissell, D. D., Principal of the Hampton Normal and Agricultural Institute, and Isabel Bevier, Professor of Chemistry at Lake Erie College. Pp. 45, pls. 3. Price 5 cents.

This bulletin includes two separate papers, which together report the details of nineteen dietary studies of negro families in eastern Virginia. Some had been under the influence of Hampton Institute, others had not had such training, while many families had very limited incomes. The results are discussed and compared with those of dietary studies of negroes in Alabama, and with averages of studies of families of different occupations and incomes in other regions.

Bulletin No. 77.—Dietary Studies of University Boat Crews. By W. O. Atwater and A. P. Bryant. Pp. 72. Price 5 cents.

Dietary studies are reported of the Harvard and Yale university and freshman boat crews at their quarters at their respective universities and at Gales Ferry before the annual boat race. A study of the captain of the Harvard freshman crew at Gales Ferry was also made. These investigations were undertaken primarily to secure data regarding the food requirements of men performing severe muscular work. The diet of the boat crews was found to contain more protein and to furnish more energy than that of students not engaged in such exercise. These and other observed facts are discussed in relation to the results of other dietary studies and the commonly accepted theories of nutrition.

Bulletin No. 84.—Nutrition Investigations at the California Agricultural Experiment Station, 1896–1898. By M. E. Jaffa, M. S., Assistant Professor of Agriculture, University of California. Pp. 39. Price 5 cents.

This bulletin reports four dietary studies of infants, one of the university football team during training, and one of a chemist's family. A digestion experiment with an infant on a milk diet was also made, as well as a metabolism experiment in which the balance of income and outgo of nitrogen was determined. The results are discussed at considerable length.

Bulletin No. 85.—A Report of Investigations on the Digestibility and Nutritive Value of Bread. By Chas. D. Woods, Director, and L. H. Merrill, Chemist, Maine Agricultural Experiment Station. Pp. 51. Price 5 cents.

This technical bulletin is a progress report giving the results of experiments with men on the digestibility of bread of various kinds when eaten alone and when forming part of a simple mixed diet. Artificial digestion experiments with the same sorts of bread were also made, and the metabolic nitrogen in the feces and methods of estimating it were studied. In the experiments with men the balance of income and outgo of nitrogen was determined. A test of skim milk versus water for use in mixing dough showed the value of the former, as the resulting bread was richer in protein than that mixed with water. The loss of nutrients which is observed in bread making was also studied.

Bulletin No. 89.—Experiments on the Effect of Muscular Work Upon the Digestibility of Food and the Metabolism of Nitrogen, conducted at the University of Tennessee, 1897 to 1899. By Chas. E. Wait, Ph. D., F. C. S., Professor of Chemistry at the University of Tennessee. Pp. 77. Price 5 cents.

Sixteen experiments are reported in which the effect of muscular work upon the digestibility of food and upon the metabolism of nitrogen was studied. The subjects were young men in good health and performed muscular work under different dietary conditions.

Bulletin No. 91.—Nutrition Investigations at the University of Illinois, North Dakota Agricultural College, and Lake Erie College, Ohio, 1896 to 1900. By H. S. Grindley and J. L. Sammis, E. F. Ladd, and Isabel Bevier and Elizabeth C. Sprague. Pp. 42. Price 5 cents.

This bulletin reports dietary studies. The two at the University of Illinois were made with the family of an instructor and a club of workingmen; the study at the North Dakota Agricultural College, with a club of woman students; and that at Lake Erie College also with a club of women, including students and instructors. The investigations are discussed and compared with the results of similar work carried on elsewhere in the United States.

Bulletin No. 98.—The Effect of Severe and Prolonged Muscular Work on Food Consumption, Digestion, and Metabolism. By W. O. Atwater, Ph. D., and H. C. Sherman, Ph. D., and the Mechanical Work and Efficiency of Bicyclers, by R. C. Carpenter, M. S. Pp. 67, figs. 3. Price 5 cents.

A six-day bicycle race at Madison Square Garden, New York City, afforded the authors an opportunity to study the effect of very severe and prolonged muscular work upon the consumption and digestibility of food and the metabolism of nitrogen. The results are compared with those obtained under other conditions of muscular work. In the chapter devoted to a consideration of the mechanical work and efficiency of bicyclers, the amount of work actually performed is discussed, as well as the efficiency of man considered as a machine, and related topics.

Bulletin No. 101.—Studies on Bread and Bread Making at the University of Minnesota in 1899 and 1900. By Harry Snyder, B. S., Professor of Chemistry, College of Agriculture, University of Minnesota, and Chemist of the Agricultural Experiment Station. Pp. 65, pls. 3, fig. 1. Price 5 cents.

Continuing earlier work, digestion experiments were made with bread from whole-wheat flour, graham flour, and standard patent flour, the flours all being ground from the same lot of hard Scotch Fife spring wheat. The standard patent flour, as shown by analysis, contained somewhat less total protein than the flours of lower grade, but was more thoroughly digested. Artificial digestion experiments with bread of different kinds were made as well as studies of the effect on digestibility of consuming different amounts of oatmeal and of bread, the effect on digestibility of increasing the proportion of starch in bread, and experiments in bread making.

Bulletin No. 102.—Experiments on Losses in Cooking Meat, 1898–1900. By H. S. Grindley, D. Sc., Professor of Chemistry, College of Agriculture, University of Illinois, with the cooperation of H. McCormack, M. S., and H. C. Porter, M. S. Pp. 64. Price 5 cents.

Twenty-nine experiments on the losses of material when meat is fried, stewed, and boiled are reported. The experimental methods followed are described and the results are briefly discussed. The present bulletin is a progress report.

Bulletin No. 107.—Nutrition Investigations among Fruitarians and Chinese at the California Agricultural Experiment Station, 1899–1901. By M. E. Jaffa, M. S., Assistant Professor of Agriculture, University of California. Pp. 43. Price 5 cents.

This bulletin includes six dietary studies, a digestion experiment, and a study of the metabolism of nitrogen made with persons living practically on a diet of fruit and nuts; also three dietary studies with Chinese engaged in light muscular work, moderate muscular work, and severe labor. The diet of the fruitarians furnished

less nutrients and energy than the average diet of persons of similar age and occupation consuming ordinary foods. Instances are, however, on record in which persons consuming a mixed diet have lived on as small amounts. The diet of the Chinese corresponded quite closely as regards nutrients and energy to that of Americans engaged in similar work. Studies like those here reported are useful in determining dietary standards and in similar ways. The results obtained are discussed in relation to the general laws of nutrition.

Bulletin No. 109.—Experiments on the Metabolism of Matter and Energy in the Human Body, 1898 to 1900. By W. O. Atwater, Ph. D., and F. G. Benedict, Ph. D., with the cooperation of A. P. Bryant, M. S., A. W. Smith, M. S., and J. F. Snell, Ph. D. Pp. 147. Price —— cents.

Continuing earlier work with the respiration calorimeter, details are reported of thirteen metabolism experiments with the respiration calorimeter, in which the balance of income and outgo of matter and energy was determined. Improvements in the apparatus and methods of experimenting are also reported, as well as the results of experiments designed to test the accuracy of the respiration calorimeter. The bulletin concludes with a chapter summarizing the results which have been obtained in experiments like those reported. These conclusions have to do with such questions as the total carbon dioxid and water excreted per day, the amount excreted at night as compared with those excreted during the day, and similar topics. In many cases new values are given for physiological constants.

PUBLICATIONS NO LONGER AVAILABLE.

(These publications can not be supplied by the Department of Agriculture or the Superintendent of Documents.)

Circular No. 43.—Foods—Nutrients—Food Economy. Pp. 6, diags. 2.

A very brief statement of the functions of food and the general principles of nutrition.

Farmers' Bulletin No. 23.—Foods: Nutritive Value and Cost. By W. O. Atwater, Ph. D. Pp. 32, diags. 2. Replaced by Farmers' Bulletin No. 142.

This contains definitions of the technical terms used in discussing the nutritive value and economy of foods, tables, and explanations of the nutritive value of common food materials, and suggestions regarding errors to be avoided.

Bulletin No. 56.—History and Present Status of Instruction in Cooking in the Public Schools of New York City. Reported by Mrs. Louise E. Hogan, with an introduction by A. C. True, Ph. D. Pp. 70, pls. 12.

This bulletin includes an account of the introduction, growth, and present status of teaching cooking in the public schools of New York City. Sample lessons are quoted which show the course at present followed and exercises, both compositions and drawings prepared by pupils, are also given.

Foods for Man. Pp. 7. Reprinted from Yearbook of Department of Agriculture for 1897. Replaced by Circular No. 46.

The functions of food are briefly described, and the method of calculating a dietary is given, as well as the composition of a number of the more common food materials.

Food and Diet. By W. O. Atwater, Ph. D. (Charts I–IV, size 26 by 40 inches.)

Chart I.—Nutrients of Food and Their Uses in the Body. This shows in tabular form the composition of food materials as purchased with examples of the different nutrients and functions of each. The definition of food is also given.

Chart II.—Composition of Food Materials. This shows by means of colored lines the composition and fuel value of a number of common food materials, both animal and vegetable.

Chart III.—Pecuniary Economy of Food. This gives the amount of a number of food materials which may be purchased for 10 cents, and shows by means of colored lines the composition and fuel value of each.

Chart IV.—Dietaries and Dietary Standards. This shows by means of colored lines the nutrients and fuel value of the dietaries consumed by the people of various conditions in the United States and other countries. The dietary standards for a man at little work, at moderate work, and at severe work are also given.

INDEX OF NAMES.

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